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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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In the Matter of CREBD & COMPANY, LIMITED (and Reduced),
and
In the Matter of the COMPANIES' ACTS, 1908 and 1913.

Notice is Hereby Given

that a Petition has been presented to the High Court of Justice for Confirming a Resolution of the above Company for reducing its capital from £130,000 to £90,000. A list of the persons admitted to have been creditors of the Company on the 23rd day of May, 1917, may be inspected at the Offices of the Company at 3, Addiscombe Road, East Croydon, or at the Office of the undersigned, 7, St. Mildred's Court, Poultry, E.C., at any time during usual business hours, on payment of the charge of One Shilling.
Any person who claims to have been on the last-mentioned day and still to be a creditor of the Company, and who is not entered on the said list and claims to be so entered, must, on or before the 23rd day of June, 1917, send in his name and address, and the particulars of his claim, and the name and address of his solicitor (if any), to the undersigned, at 7, St. Mildred's Court, Poultry, aforesaid, or in default thereof he will be precluded from objecting to the proposed reduction of capital.
Dated this 25th day of May, 1917.
HAIR & CO.,
Solicitors for the said Company. G 870

STRUCTURAL ENGINEERING.

For Particulars of Course of

INSTRUCTION by CORRESPONDENCE, write to "THE WESTMINSTER ENGINEERING BUREAU," 25, Old Oak Road, Acton Park, London, W. 5028

Penningtons. — Engineering

Tutors for A.M.I.C.E., A.M.I.M.E. and A.M.I. H.E. Aeronautical Draughtsmanship and Design; Aero Engines.—264, Oxford Road, Manchester. 5397

TENDERS.

COUNTY BOROUGH OF NEWPORT.

TRAMWAYS DEPARTMENT.

The Corporation invite

Tenders for the Construction

of NEWPORT LIGHT RAILWAY, Section No. 2. Form of Tender, Specification, Bill of Quantities, and Plans may be obtained on application to A. NICHOLS MOORE, M.I.E.E., Borough Electrical and Tramways Engineer, Town Hall, Newport, Mon., on payment of £3 3s., which will only be returned on receipt of a *bona fide* Tender.
Tenders must be enclosed in a sealed cover and addressed to the Town Clerk, Town Hall, Newport, Mon., and endorsed in the left-hand corner "Tender for Construction of Light Railway," and delivered at my Office by hand, or through the post (registered) not later than Ten a.m. on the 9th of June, 1917.
The lowest or any Tender not necessarily accepted.

ALBERT A. NEWMAN,
Town Clerk.
Town Hall, Newport, Mon.,
25th May, 1917. G 884

OLDHAM CORPORATION ELECTRICITY WORKS.

PLANT FOR SALE.

The Oldham Corporation Electricity Committee offer

For Sale, the following

PLANT:—
Two WILLANS-SIEMENS 740 Kw. SETS, shunt wound, 450/480 volts.
The plant is in good working condition, and can be seen by appointment.
Further particulars can be obtained from Mr. F. L. OGDEN, Joint Engineer and Manager, Electricity Works, Greenhill, Oldham.
The highest or any Tender not necessarily accepted.

J. H. HALLSWORTH,
Town Clerk.
Town Hall, Oldham. G 883

IN THE MATTER OF THE TRADING WITH THE ENEMY AMENDMENT ACT, 1916.

The PUBLIC TRUSTEE invites

Tenders for the Purchase of

the Whole or any part of 119,660 Shares of £5 each, fully paid, in SIEMENS BROTHERS & COMPANY, LIMITED, vested in him as Custodian by an Order made by the Board of Trade, in pursuance of Section 4 of the Trading with the Enemy Amendment Act, 1916, and dated 9th August, 1916.
The issued capital of the Company consists of 120,000 Shares of £5 each, fully paid.
The purchasers, who must be British-born subjects, will be required to make a sworn Declaration as to nationality and freedom from foreign control on a form to be obtained from the Offices of the Public Trustee.
The purchasers will also be required to satisfy the Public Trustee as to their financial and technical ability to carry on the business of the Company as efficiently as heretofore, or otherwise to the satisfaction of the Government.
A report upon the Company's operations and affairs has been prepared by the Company, in conjunction with the Company's Auditors (Messrs. PRICE, WATERHOUSE & Co.), and with Messrs. TURQUAND, YOUNGS & Co. Copies of this report can be obtained, subject as hereinafter mentioned, together with copies of Company's accounts up to the 31st December, 1916, on written application to the Public Trustee, Kingsway, W.C.
All applicants will be required to satisfy the Public Trustee as to any matter which he may think fit to investigate before copies of such Report or accounts will be supplied.
Intending Tenderers who desire to inspect the property of the Company, should apply to the Public Trustee for an authority to do so.
Tenders must be delivered, sealed, to the Public Trustee, Kingsway, W.C., on or before Thursday, the 12th July, 1917 (NOT 14TH JUNE, AS PREVIOUSLY ADVERTISED), at Twelve o'clock Noon, and marked on the envelope, "Tender, Siemens Shares."
The Public Trustee does not bind himself to accept any Tender, and reserves to himself all rights in connection therewith.
Forms of Tender can be obtained from the PUBLIC TRUSTEE.
Dated this 8th day of February, 1917. 5942
C. J. STEWART, Public Trustee,
Custodian for England and Wales.

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BRISTOL EDUCATION COMMITTEE.

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September 3rd next, for the above School, a TEACHER of ENGINEERING SUBJECTS, including Metal Work and Machine Drawing. Preference given to a Practical Engineer with teaching experience.
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WM. AVERY ADAMS,
Secretary for Education.
Guildhall, Bristol.
26th May, 1917. G 889

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There is a Vacancy in a Large

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For a really capable man there would be adequate remuneration and excellent prospects.
No one already engaged on Government work or living more than ten miles away need apply.
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G 783

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Foundry in South of England. Must have good knowledge of chemistry, and be thoroughly conversant with latest foundry practice. Liberal salary to first-class man.—Write BOX 8463, care of A. J. WILSON & Co., LTD., 154, Clerkenwell Road, London, E.C. 1. G 768

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experience of works management and design, for Responsible Position, with general supervision of two works at present on war work, engaged after the war on variety of special light engineering work.—Address, G 852, Offices of ENGINEERING.

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for large works in the Midlands, producing Wrought and Cast Ironwork. Permanent situation. Practical works knowledge and previous experience in costing essential. No person already on Government work will be engaged.—Apply, stating full particulars and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 3238. G 848

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for engineering works on munitions; to teach women turning, fitting, machine minding, &c. No one on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 888.

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thoroughly capable, energetic man with experience of efficient drawing office system and management, for engineering works engaged on Government contracts for high class automatic and capstan repetition work. Sound knowledge of tool and jig design essential. State age, experience, and salary required.
No one employed on Government work will be engaged.—Apply at your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3161. G 895

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Required by Controlled Engineering

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Technical, commercial and thoroughly practical engineer, wide experience of works organisation and administration, rapid and economical production of high-class, interchangeable, competitive repetition work, munitions, motor and general engineering. Maximum output from labour and machines. Has held position of general manager for past 13 years with up-to-date progressive firm.—Address, G 855, Offices of ENGINEERING.

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LITERATURE.

Depreciation and Wasting Assets and their Treatment in Computing Annual Profit and Loss. By P. D. LEAKE, F.C.A. London: Sir Isaac Pitman and Sons, Limited. 1917. [Price 12s. 6d. net.]

ACCOUNTANCY is perfecting its scientific equipment. Looseness of statement, of method, and of reasoning is meeting with deserved reprobation, and logical preciseness is urged as a welcome substitute. The author, in the foremost rank of reformers, perceiving common fallacies and dangers surrounding one class of problems—the adequate treatment of wasting assets—directs attention to these, attacking the inaccurate methods that have long survived in an unsatisfactory method of book-keeping with equal thoroughness and lucidity. At the present moment there are at least two obvious considerations that make the scientific treatment of wasting assets, as affecting the rigorous determination of industrial profit, a matter of extreme importance. One is the continually increasing pressure that labour is exerting on capital with the view of participating to a greater extent in the proceeds of united effort; the other is the exaction by the State Exchequer of excess profits with such severity that justice to the State and self-protection alike demand the composition of an exact and incontrovertible balance sheet. On both grounds the items that indicate an apparent profit or loss demand the most careful sifting.

We are perhaps inclined to regard wasting assets in too narrow a light by confining attention to the more glaring forms, or what the author calls "inherent waste." Such forms include leasehold properties, investments in mining shares, or traffic in natural products limited in quantity and irreplaceable after removal; less noticeable is all the industrial and perishable material that requires periodic renewal in the task of profit-seeking or the pursuance of commercial enterprise. When the picture of universal wear and tear is summoned up, there is still left out of consideration such immaterial property as copyright, patent rights, goodwill, trade marks, and capital sunk in the purchase of rights to the enjoyments of the profits of future years. Such profits should no more be neglected than the purchased assets that evidently become exhausted in the course of trade. Mr. Leake, recognising that a wasting asset implies the loss of capital, and desirous for a more exact or descriptive term than "depreciation" to express the inevitable loss wrought by time and use or obsolescence, prefers "expired capital outlay," not unexceptionable as a definition, for it involves the meaning and significance of capital, a term quite as hard of definition as "depreciation." It is, however, more important to understand the sense in which the term is used here, and this may be shown perhaps most clearly by an example. Suppose a tramway company constructs a line when material and labour are dear. At a later date the line could have been constructed for half the money, and its present value is only half of what it cost. Does this loss imply "expired capital outlay," and would sound finance require the company to make the loss good before a dividend is paid? Or if the line were constructed when labour was cheap and prices rose after completion, may the company divide this apparent gain as dividend? "Upon such a principle dividends would vary enormously and sometimes inversely to the actual profit of the concern." This problem was submitted by Lord Justice Buckley, and the author's answer is given without ambiguity. "The tramway company . . . having made a bargain and bought the property, whether the price was high or low, the sole question for the company in preparing its annual revenue accounts is as to how the cost, which is expiring over a long period of years, is to be fairly allocated as a charge against the revenue account of each year for expired capital outlay." All subsequent fluctuations in the value of material and labour are regarded as irrelevant. The actual capital expended in the construction has to be replaced within the life of the undertaking, and this principle is to be regarded as everywhere operative. It is not infrequent for mining claims to double or treble in value in the course of operations. All who participate in a dividend receive an equal amount per share, which includes a portion of the capital, as well as of the profit of the enterprise, but those who have come in on the "ground floor" have a smaller allowance to make for depreciation than those who have entered later. But it is imperative on all to apportion the subscribed capital, however variable in amount, to the probable life of the undertaking. This inequality of distribution among the proprietors is perhaps one of the reasons that have determined the income-tax authorities, when assessing income-tax on such investments, to refuse to allow deduction from the annual revenue receipts of the necessary provision for wasted capital. The result of this unscientific manner of collecting income-tax from this class of undertakings is that both capital and profit are mulcted by the tax collector, to the advantage of the Exchequer.

But although the assessment of income-tax on a correct basis is put forward as one ground for increased attention to a troublesome problem, the author has in view the establishment of a sounder policy, founded on an improved system of book-keeping. His plan is one of detail rather than of essentials. Every well-managed undertaking makes some, and probably sufficient, provision for waste and depreciation, but the author's righteous soul is vexed at the unmethodical way in which the total depreciation is charged to annual revenue. One principal object of this treatise is to indicate a systematic plan, by which results approaching accuracy can be substituted for the precarious methods now in vogue. A main difficulty arises from the fact that in every large concern there must be innumerable units of industrial plant, the duration of whose respective lives varies enormously. A railway bridge will last longer than the rolling-stock that passes over it, a workshop will outlive the machinery that is erected in it. This variation in the length of life eludes the ordinary methods of book-keeping, the more easily as in any suggested process vagueness and uncertainty cannot be entirely eliminated; the accuracy attainable cannot approach that which accompanies direct financial records. No doubt a source of danger lurks in the unscientific manner in which a lump sum is written off to cover waste and depreciation. As an experienced chartered accountant, Mr. Leake deliberately asserts that the present state of confusion and chaos in the records of capital outlay on industrial plant is appalling. We should think that this overstates the case. If, as hinted, the present financial position of large undertakings, such as railways, is unsound or undiscoverable, because the going-concern value of the unexpired capital outlay is overestimated, this position arises probably from the pursuit of a deliberate policy, and not from the particular methods in which the accounts are kept.

It may be unjust to any author to attempt to summarise within a few sentences a plan whose full elaboration requires a whole treatise, but the significant feature in the author's remedy for the evils he deplores is a more distinct exhibition of the employment of capital outlay and depreciation by a separation of the various items forming the industrial plant into classes. Instead of one item of depreciation, we have the sum of many, each one of which can be allotted its own length of life. Such a plan is better calculated to ensure a more exact oversight of the various details. The annual amount to be written off will be the sum shown in detail in the class register, not necessarily to be disclosed in full to the shareholders. Naturally, the increase in clerical work will be considerable, and it is difficult to see why a greater degree of accuracy should be attainable in dealing with the sum of a number of small items, each accompanied by an error of unknown amount, than in one total embracing the whole of the depreciation, as in the usual method. Many safeguards are proposed, but it is difficult to see how these would work in practice, especially the demand that every joint-stock and municipal trading concern should be compelled by statute to keep a register of plant, in which the year of purchase and the cost of each of the various classes of industrial plant in which capital is invested should be recorded under proper heads. The estimates of engineers and technical advisers are to be shown in this register, to enable accountants to give due financial effect to such information. Mr. Leake gives an example of such a register applied for a number of years to the case of an electrical tramway undertaking, in which the units are boilers, turbines, transformers, cars, &c. To these a different, but arbitrary, length of life is accorded, and the plan is attractive, but a comparison between an academical example and the results of practice is apt to prove misleading.

On other practical points, such as the application of a sinking fund to the extinction of original outlay, and the fallacies that underlie some specious schemes for the same object, sound information and valuable advice is given, though the obvious is sometimes unduly emphasised. But it is occasionally necessary to insist on the obvious; the beautifully adjusted accounts in a balance-sheet may conceal much undesirable jugglery or unconscious ignorance, and if these figures be dissected the apparent may be found to have successfully obscured the true meaning. He is doing good service who strips off the ornamental covering that precludes scrutiny and endeavours to confront us with the naked, if unpalatable, truth. Everyone would condemn in theory the practice that represents the profits of a business, year by year, at a larger sum than is warranted, and in consequence recommends the payment of a dividend from moneys that arise partly from true profits and partly from realisations of portions of the value originally represented by capital outlay on plant. Yet from ignorance, more often than from design, such misrepresentations are made, and every effort designed to improve the management or to enlighten an indifferent public is to be welcomed.

The author concludes with three chapters which illustrate some or other of the fallacies he would expose, or suggest the adoption of the method he would recommend. In the first of these he analyses the decisions of the Court that investigated the claims of the National Telephone Company at the time of the transference of the company's assets to Government control. Two different methods of measuring depreciation were then thoroughly discussed, and the criticism of the arguments presented and of the judgment of the Court is informing. The second case considered is that of the London Electric Supply, and an alternative method of finance is suggested which is of quite general application. The third discusses the proposals by which the Ministry of Munitions intend to treat the question of depreciation in controlled workshops. At this time these remarks are opportune, and Mr. Leake credits this Government Department with being the first to perceive and apply sound principles founded on a just and scientific basis.

The Fan, including the Theory and Practice of Centrifugal and Axial Fans. By CHARLES H. INNES, M.A. Revised by W. M. WALLACE, Wh.Sc., A.R.C.Sc., and F. RABY JOLLEY, M.Sc.Tech. Second Edition. London: The Technical Publishing Company, Limited. [Price 8s 6d. net.]

SINCE this book was published in 1904 the fan has assumed new forms and found useful application in many directions. Its more varied use has led to increased inquiries concerning its design and efficiency, and a new work would probably have been preferable to this extension. Mr. Innes was, we believe, the first to connect the theory of the fan with that of the centrifugal pump, to which a close resemblance is traceable, though the fan does not actually lift air as a pump does water. The treatise was written to urge this point of view, and the author was not a little influenced by the dissatisfaction he felt with the fundamental formula—

$$H = \frac{K v_2^2}{1 + \frac{c^2}{a^2}}$$

where H is the head of air against which the fan works, v_2 the peripheral velocity, a is a constant for any particular fan, and c is the equivalent orifice. Very good reasons can be given for mistrusting the general applicability of this formula, and Mr. Innes preferred an expression of the form—

$$v_2^2 + P c^2 Q - R Q^2 - S g H = 0.$$

where P, R, S, are constants depending upon the construction and angle of the vanes, and Q is the

volume of air passing through the fan. The plan of the work required, therefore, a thorough discussion of the theory of the various fans considered, and a comparison between the experimental results and the theoretical values. This scheme was carried out very thoroughly, and the treatise must have been appreciated by manufacturers and the designers of fans for the wealth of detail and descriptive matter supplied. The limitations imposed by theoretical deductions could be easily followed, and the directions in which greater efficiency could be attained were clearly indicated. The revisers wisely have made no great alterations in the author's original work: the historical value is unimpaired. The early experiments of Heenan and Gilbert, undertaken with the view of determining the best shape of fan blade and fan case, are described in sufficient detail; we can still refer to the experimental work of Bryan Donkin on the Rateau fan, and that of many later workers, with Mr. Innes' careful comparisons between the calculated and observed manometric efficiency. Some of these investigations have a rather old-world look about them. The experiments of the Prussian Commission to test the trustworthiness of the Pitot tube carry us back to 1884, and some are of an older date, but are memorable as epochs in the history of the progress of mechanical science. It is interesting to note that one of the registering instruments used in testing the quantity of air discharged by a fan—the anemometer—still fails to give satisfaction, and a reliable form of anemometer, or accurate methods of graduating those in use, remains for the work of the future. The method usually employed of testing the performance by rotating the instrument at the end of a long arm driven at uniform velocity through still air, suggested or practised by Mr. Dines, exaggerates the quantity of air passing through it. In particular experiments anemometers carefully tested in this way by motion at the end of a radius bar showed errors ranging from 7 to 13 per cent. when compared with direct measurement of air. Some advance, however, has been made, problems in aviation have directed attention to the need of accurate measurement of air velocities, and improvements have been made in the method of registration as in the interpretation of the records, but the editors have not thought it necessary to refer to any of these, though here, as in some other places, the progress made in 12 years might have been indicated by a brief footnote with a reference in the rather scanty bibliography attached.

Though the discussion of the theory of centrifugal fans was Mr. Innes' principal aim, he added some chapters on the more novel forms of high-pressure fans, helical propellers and of Rateau screw fans, though the theory of some of these forms could not be regarded as complete because the published experiments failed to supply the necessary data. We had hoped, therefore, that the authors would have taken up this subject where it was left, and, provided with accurate information, would have pursued the same kind of analysis with the thoroughness that characterised the previous edition. But in the final chapter, for which Messrs. Wallace and Jolley are responsible, little attempt is made to go beyond the description of some mechanical improvements that have been introduced into fan design. For example, in the matter of centrifugal fans, the devices proposed by Mr. S. C. Davidson to overcome the cyclonic movement of air in some types of fan arising from the reduction of pressure at the inlet are described and illustrated, but there is no discussion of experiments to show how far these precautions have been successful or any comparison with other contrivances that have been suggested.

On the important point of judicious arrangement of fans the authors are more successful and more informing. They rightly insist that no material obstacle, or possible air currents even at some distance from the periphery of the fan, should be allowed to interfere with the flow of discharge. Here it is not so much the theory of the fan that is in question, as an improvement suggested by the molecular theory of gases. The point is rather subtle, and the action of colliding air particles in reducing efficiency might easily be overlooked but for the greater attention paid of late to physics. That a real loss can arise from molecular motion is not a mere nicety traceable to physical deduction, but is capable of demonstration with suitable instruments, and is one that demands a remedy by a more economical arrangement of apparatus where air currents from adjacent fans are likely to prove mutually destructive. Thus where fans have to be placed side by side in the stokehold of steamships, for example, it is usual to have deflectors fixed to guide the currents in such directions that the air delivered from one fan should not obstruct the delivery from one adjacent.

As an example of the application of fans to industrial purposes, a division of the subject that Mr. Innes left practically untouched, we may select the process here described for purifying gases containing tar or dust in suspension, by passing the impure mixture through a specially devised form of fan, causing the solid particles to be thrown by centrifugal action against the interior surface of the volute, while the purified gas passes to the discharge duct. Special devices have to be provided for detarring, and, as in many engineering plants, opportunity is afforded for the introduction of economical contrivances for utilising what would prove a loss of energy. Rateau's arrangement of a fan and turbine in series is well described. Details of exhaust fans for carrying away deleterious fumes arising from the prosecution of dangerous trades, and of air-pressure fans for creating the blast for furnaces in inconvenient situations, are new and valuable features introduced in this edition. An ingenious imitation of the Pelton wheel, in which a stream of air impinges on buckets at the periphery of the fan is described, and compressors of various kinds are treated with explanatory details. The references to recent patents will no doubt be appreciated by practical authorities. The authors address a somewhat different audience from that contemplated by Mr. Innes, but by entering into these practical applications they have succeeded in enhancing the usefulness of the book without diminishing its original interest.

How to Lay Out Turret Lathe Tools. A Handbook for those who Design Tools for Use on Turret or Capstan Lathes and Automatic Turning Machines. Coventry: Alfred Herbert, Limited. [Price 2*s.* 6*d.*]

WE have here a most valuable addition to the library of the mechanical engineer. The volume is from beginning to end full of sound practical information clearly stated, and dealing with many points of workshop practice concerning which little of real value has hitherto been written. The book is divided into 24 chapters, of which the first is a short one treating of some preliminary considerations which have to be taken into account in connection with the production of work on a capstan or turret lathe, and this is followed by a chapter on the general laying-out of the tools required for the production of a given article. Then follow chapters dealing respectively with chucking, fixture design, milling, boring and reaming, turning, facing and forming, profiling, screwing with a self-opening diehead, chasing, tapping and screwing, and recessing. In all these chapters the information given is thoroughly to the point and the explanations are materially aided by the excellent series of illustrations.

Chapter XIV deals with typical lay-outs and contains descriptions of the tools actually used in machining the brass fuse bushes of high-explosive shells, and those employed for producing the propeller boss of an aviation motor. The next chapter is devoted to special attachments, and then follows one on shell-boring, a subject of particular interest at the present time. Then comes a short chapter on automatic turning machines, this being followed by five others dealing with the special points to be considered in carrying out the operations of chucking, drilling and boring, turning, facing and forming, profiling and tapping and screwing in machines of this class. The instructions given in these chapters are supplemented by an account in Chapter XXIII of a typical automatic turning machine lay-out, the example selected being the lay-out for machining a flywheel. A chapter on the materials used in tool work and a short one giving some general advice bring the volume to a conclusion.

The book is admirably illustrated and well printed. The name of the author is not given on the title-page, but this is no reason why we should not congratulate him on the terseness of his style and the clearness with which he describes the practical points which must receive attention in order to secure the best results from the classes of machine tools with which he deals.

BOOKS RECEIVED.

On Growth and Form. By D'ARCY WENTWORTH THOMPSON. London: Cambridge University Press, Fetter-lane, E.C.; New York: C. P. Putnam's Sons. [Price 21*s.* net.]

Railway Statistics of the United States of America for the Year ending June 30, 1916. Prepared by SLASON THOMPSON, Bureau of Railway News and Statistics. Chicago: Stromberg, Allen and Co.

The "Combination" Russian Ready Reckoner. By C. T. EVENNETTE. London: J. Halden and Co., Limited, 15 and 17, Broadway, Westminster. [Price 1*s.* 3*d.*]

Liverpool Shipping: A Complete Directory of the Shipping and Allied Industries of the Ports of Liverpool and Manchester. 1917 Edition. Liverpool: *The Journal of Commerce.* [Price 1*s.*]

The Mercantile Year Book and Directory of Exporters, 1917. Edited by WALTER LINDLEY-JONES, F.R.G.S. London: Lindley-Jones and Brother. [Price 16*s.*]

Judicial Interpretations of the Munitions of War Acts, 1915 and 1916. By JOHN CHABTRES. London: Stevens and Sons, Limited. [Price 4*s.* net.]

The Principles of Apprentice Training, with Special Reference to the Engineering Industry. By A. P. M. FLEMING and J. G. PEARCE. London, New York, Bombay, Calcutta and Madras: Longmans, Green and Co. [Price 3*s.* 6*d.* net.]

Motor Repair Work for the Amateur Mechanic and Owner-Driver. London: Temple Press, Limited. [Price 1*s.* net.]

Practical Marine Engineering for Marine Engineers and Students, with Aids for Applicants for Marine Engineers' Licences. Fourth Edition, revised and enlarged. By CAPTAIN C. W. DYSON, U.S.N. New York: *Marine Engineering*, 461 Eighth Avenue.

Department of the Interior: United States Geological Survey. II: 12. *Potash Salts*, 1915. By W. C. PHALEN. *With Simple Tests for Potash.* By W. B. Hicks. I: 7. *Bauxite and Aluminium in* 1915. By W. C. PHALEN. Washington: Government Printing Office.

Operation of Gas Works. By WALTER M. RUSSELL. New York: McGraw-Hill Book Company; London: Hill Publishing Company, Limited. [Price 8*s.* 4*d.* net.]

A National System of Economics. By J. TAYLOR PEDDIE, F.S.S. London: University of London Press, Limited. [Price 5*s.* net.]

Office Machinery: A Handbook for Progressive Office Managers. By LAWRENCE R. DICKSEE, M.Com., F.C.A. London: Gee and Co. [Price 6*s.*]

Air Power, Naval, Military, Commercial. By CLAUDE GRAHAME-WHITE and HARRY HARPER. London: Chapman and Hall, Limited. [Price 7*s.* 6*d.* net.]

Steel and its Heat Treatment. By DENISON K. BULLENS. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 17*s.* 6*d.* net.]

Turbines Applied to Marine Propulsion. By STANLEY J. REED, Assoc.M.Inst.C.E. Second edition, revised and enlarged. London: Constable and Co., Limited. [Price 16*s.* net.]

Les Salaires Ouvriers et la Richesse Nationale. Par F. BAYLE. Paris: H. Dunod et E. Pinat. [Price 6.50 francs.]

Calculus. By HERMAN W. MARCH, PH.D. and HENRY C. WOOLF, Ph.D. New York: McGraw-Hill Book Company, Inc.; London: Hill Publishing Company, Limited. [Price 8*s.* 4*d.* net.]

English and Engineering: A Volume of Essays for English Classes in Engineering Schools. Edited by FRANK AYDELOTTE. New York: McGraw-Hill Book Company, Inc.; London: Hill Publishing Company, Limited. [Price 6*s.* 3*d.* net.]

Leçons sur les Fonctions Elliptiques en vue de leurs Applications. Par R. DE MONTESSUS DE BALLORE. Paris: Gauthier-Villars et Cie. [Price 12 francs.]

Department of the Interior, Canada, Water Power Branch, J. B. CHALLIES, *Superintendent. Water Resources Papers.* No. 2. *Bow River Power and Storage Investigations.* By M. C. HENDRY. B.A.Sc. No. 7 *Manitoba Water Powers.* By D. L. MCLEAN, S. S. SCOVIL and J. T. JOHNSON. No. 12. *Small Water Powers.* By A. M. BEALE, B.Sc. No. 13. *Coquitlam-Buntzen Hydro-Electric Development, British Columbia.* By G. R. G. CONWAY. No. 17. *Canadian Hydraulic Power Developments and Electric Power in Canadian Industry.* Ottawa: J. de la Taché.

The Homeland Handbooks. Kingsbridge, Salcombe and the Kingsbridge Estuary. By ARTHUR HENRY ANDERSON. London: The Homeland Association, Limited. [Price 7*d.* net.]

The Design of Machine Elements: A Handbook for Students and Draughtsmen engaged in Engineering Design. By W. G. DUNKLEY, B.Sc. In two volumes. Vol. I—*Forces and Stresses; Shafting and Bearings; Couplings; Springs.* Vol. II—*Screws and Bolts; Clutches; Belts and Pulleys; Gearing.* London: Scott Greenwood and Son. [Price 4*s.* 6*d.* each volume.]

Differential Calculus. By H. B. PHILLIPS, Ph.D. New York: John Wiley and Co., Inc.; London: Chapman and Hall, Limited. [Price 5*s.* 6*d.* net.]

THE GERMAN RAILWAY RECORD IN CHINA.

MUCH has been written about German commercial methods and achievements in China, but little about the cost of construction and management of those Chinese railways for which Germans are, or have been, responsible. Germany has constructed two railways in China, the Shantung Railway and the Northern Section of the Tientsin-Pukow Railway, both of which are in the province of Shantung. The first is 284 miles in length, and was built with German capital for a German company, and opened for traffic in 1904. It connects the once-German port of Tsingtau with the capital of Shangtung, province Tsinanfu. The line was exceedingly costly considering the easy country traversed, but as this line probably created German standards of construction for other German ventures, an analysis of the cost of the line taken from German sources is worthy of some study. The details are as follow:—

	£	
Land	89,700	317*l.* per mile.
Earthwork ...	148,000	
Fencing	2,700	
Bridges, &c. ...	728,000	(1,325 bridges) Longest bridge 1,541 ft.—2,570*l.* per mile.
Permanent way ...	759,000	Steel sleepers, 2,670*l.* per mile.
Signals	13,200	
Stations	106,000	374*l.* per mile.
Repairing shops ...	85,000	300*l.* per mile.
Materials (coal, &c.)	310,000	
Administration ...	203,000	
Interest on capital	200,000	
	2,644,600	

(Or about 9,200*l.* per mile without rolling-stock.)

It should be noted that the mileage given for this line includes 28 miles of branch lines, whose standard of construction is inferior to that of the main line. No allowances have been made for this in the cost per mile given. The price paid for land on this line was 1.1*d.* per square yard, or 19*l.* 10*s.* per acre. This is a high initial price to pay for land, the price generally paid on the Peking-Mukden Railway for extra land required for stations being from 12*l* to 18*l* per acre at the present time, and this land has, of course, much appreciated in value. The original price was about 6*l.* per acre. The price paid for earthwork was 1.4*d.* per cubic yard, or 5.2*d.* per fang of 100 cubic feet. The amount of land bought indicates an average height of bank certainly not over 8 ft., and for this certainly no more than 4*d.* per fang should have been paid. The amount spent on stations is also high, but the type of station adopted is far more elaborate than is usual on other lines in China. The most mysterious item of expenditure is that on materials, which appears to be very heavy indeed, unless this item includes rolling-stock.

The working expenses of this line in 1912 were 432*l.* per mile. The line had paid from 4 to 6 per cent. since being opened. Since the capture of Tsingtau it has been controlled and operated by the Japanese.

Turning now to the northern section, Tientsin-Pukow Railway, the second railway for which Germany has been responsible, this line is 390.48 miles long, and was built at a cost of 11,783*l.* per mile. The country traversed is extremely easy, as shown by the limits of grade and curvature adopted, which were 1 in 150 and 1,000 m. In the whole length there is only one stretch of about 40 miles, through the Shantung mountains, which presents any engineering difficulty. In fact the earthwork of the whole would not average 10 ft. bank throughout.

The bridges are few, and the amount of major bridge opening works out at only 32 ft. per mile, minor bridges and culverts would perhaps bring the openings up to 50 ft. per mile. The largest bridge is that over the Yellow River, the combined spans of which give 4,078 ft. clear opening.

The permanent way consists of rails weighing 82 pounds per yard, laid on Japanese sleepers, there being fourteen sleepers to the 11-metre rail. Fishplates and fastenings are heavier than is usual on Chinese railways, and every sleeper has tie-plates, an unnecessary extravagance when the short life of the Japanese sleeper is considered. The road is well ballasted and well maintained. Maintenance is heavy according to Northern Railway standards, amounting to about 100*l.* per mile per year, against about 80*l.* Excessively long loops and extravagant sidings have been provided throughout. The stations are elaborate and are evidently built from standards provided by the Shantung Railway. The passenger stock is of a much rougher description than that provided on the Northern Railways. The engines are said to be excellent. Everything is of German manufacture. The line is Chinese Government property and was built with Chinese money.

In view of the extremely high cost of this line, the following costs of other railways constructed in the same region are of interest. These lines are of practically similar standards of construction:—

Name of Railway.	By Whom Built.	Rolling-stock per Mile.	Cost per Mile, including Rolling-stock.	Remarks.
		£	£	
Peking-Hankow	Belgium	1,305	8,276	90 miles double-line earthwork.
Peking Syndicate	British..	—	6,828	,, ,,
Peking-Kalgan	Chinese	1,700	8,200	No interest paid on loans.
Peking-Mukden	British..	2,470	7,625	86 miles double-line earthwork.
Pienlo ..	Belgium	1,120	9,400	,, ,,

Of the Peking-Hankow Railway the first 90 miles from Peking southwards were constructed by the British engineers of the Peking-Mukden Railway at a cost of 5,300*l.* per mile, including rolling-stock. The earthwork was for double line, and the openings worked out at 100 ft. per mile, or more than twice those on the German-built Tientsin-Pukow line. This line was built in 1899, since which time wages have risen about 25 per cent., but this would have a very slight effect on the above figures. This railway also crosses the Yellow River on a bridge of 103 thirty-metre spans, or rather more than twice the length of crossing of that on the German railway.

The Peking-Kalgan Railway has over a mile of tunnels, mostly in solid rock, and in addition openings which exceed 50 ft. per mile. For about 38 miles of its length 50 per cent. of the cuttings are in solid rock. The line was built out of the revenue of the Peking-Mukden Railway.

The Peking-Mukden Railway has openings exceeding 100 ft. per mile and at least eight bridges, totalling 156 piers, which were sunk by compressed air. Of the permanent way, 167 miles were (at the date of the construction of the Teintsin-Pukow Railway, 1908 to 1912) 85 lb., and the remainder of the 607 miles 60 lb. The large amount of rolling-stock owned by this line should also be noted. The other railways in the above list have all 80 to 85-lb. rails, except the Peking Syndicate Railway.

An estimate of cost per mile based on an average height of bank of 10 ft., and taking the prices as established by the Shantung Railway, should be of some interest. It will also be assumed that Germany abided by the clause of the loan agreement which stipulated that she should buy in the cheapest market and that all materials should be tendered for. As a matter of fact no attempt was made to carry out this clause. Tenders were duly called for, but it has been freely stated, and never officially denied, that at the date of issue of the tenders the contracts had been already placed in Germany. This condition of things was rendered possible by the complacency of the Chinese director of the railway. The defalcations of this official amounted to about 500,000*l.* on his dismissal. In this connection it should be pointed out that the loan agreement provided for the inspection of the railway accounts by a foreign official, and that the possibility of such huge embezzlement calls for some explanation. The following is the estimated cost per mile of railway on the above conditions, and a 20-ft. wide formation has been assumed. From a casual inspection it is doubtful if the line, as built, has a formation greater than 16 or 17 ft.

	£	
Survey	36	As Shantung Railway.
Land (4-ft. borrow pits) (10-ft. berm)	60	10-ft. bank.
Earthwork ...	364	,,
Bridges	2,570	As Shantung Railway.
Permanent way and ballast	1,900	Rails at 8*l.*, ballast 8*s.* 4*d.* per fang.
Stations	374	As Shantung Railway.
Shops	300	,, ,,
Rolling-stock ...	1,000	
Supervision, 10 per cent.	700	
Total cost per mile	7,304	

The amount for rolling-stock is compiled from the list of rolling-stock given in the China Year Book for 1916, and is probably in excess of what was bought to equip the line initially. The prices are taken from tenders of the southern section of the same railway, which was British built, under a similar loan agreement, and constructed at the same time.

Even allowing for the Yellow River bridge, the amount assumed for bridging is excessively high for the country traversed, the amount expended on the Peking-Hankow Railway, which traverses similar country and has more than three bridges to the mile, being 1,250*l.* per mile. But even if this excessive figure be allowed the above estimate is 4,000*l.* under the actual cost. This deficit is easily explained if the methods of construction adopted for the Yellow River bridge were standard through out the line. This bridge, as built, consists of nine spans of 91.5 m., two of 128 m. and one of 164 m., altogether a total clear opening of 4,080 ft. The river at low water (about eight months of the year) does not exceed 700 ft. in width. Rail-level is about 40 ft. above low water. The river at low water cannot be called in any sense swift-flowing.

The foundations of the piers were sunk by compressed air, the whole bridge being let by contract to a German firm for a lump sum, generally stated to be 500,000*l.* (the official cost was 531,769*l.*). This procedure of letting such work to a foreign contractor was in itself a departure from Chinese practice. The Chinese have proved excellent at compressed-air work; a large amount of this work was done departmentally during the construction of the Peking-Mukden Line, sub-contractors doing the work of sinking at a price of about 5*s.* per 100 cubic feet excavated. The cost of all work below water worked out at about 6*l.* 15*s.* per fang of 100 cubic feet. This was for work up to 60ft. below water. An estimate based on the above prices, and again on the assumption that the steelwork was tendered for, in which case it should have cost 9*l.* 10*s.* per ton, according to the prices paid on the British section of the railway, should be of some interest. It is as follows:—

	£
All work below water, including concrete, caisson, &c.—	
6,100 fang, at 6*l.* 15*s.* per 100 cub. ft. (sunk 60 ft.)	38,125
2,706 fang concrete in piers and abutment, at 4*l.* (sunk 40 ft.)... ...	10,824
6,240 tons of steel, at 14*l.*, including erection (4*l.*)	87,360
Contingencies, 10 per cent.	13,630
Total estimated cost... ...	149,939

There is very little doubt that the bridge as designed involved an excessive weight of steelwork. There can be no question that for this height of pier either an arrangement of twenty-one 200-ft. spans, or possibly four 200-ft. spans, for the river (dry weather flow), and for the rest thirty-three 100-ft. spans, would have been a more economical arrangement. The estimates for the two bridges proposed above are as follow:—

	£
All work below water, as above caisson, sunk 60 ft.	
6,600 fang, at 6*l.* 15*s.*	42,550
2,860 fang concrete in piers, at 4*l.*...	11,440
3,318 tons of steel at 13*l.*, including erection (3*l.*)	43,134
Contingencies, 10 per cent.	9,912
Total estimated cost... ...	107,036

The estimate for the second arrangement of four

200-ft. spans and thirty-three 100-ft. spans is as follows :—

	£
Four 200-ft. spans with foundations as above	18,880
All work below water on 33 piers for 100-ft. spans—	
4,950 fang, at 6*l.* 15*s.* (piers sunk 60 ft.)	33,411
3,050 fang concrete in piers, at 4*l.* ...	12,200
1,254 tons of steel, at 11*l.*, including erection (1*l.*)	13,794
Contingencies, 10 per cent. ...	7,828
Total estimated cost... ...	86,113

The total weight of steel in this last bridge is 1,886 tons, and it is 64,000*l.* cheaper than the bridge as designed. The saving in steelwork is 4,354 tons. German manufacturers, therefore, profited to this amount at the expense of the Chinese Government. No one is prepared to deny the capability of German engineers, and there is therefore only one other conclusion to adopt. Even as designed the bridge as estimated is 350,000*l.* under the lump sum contract, and if this is the profit of the contractors it adds about 1,000*l.* per mile on to the cost of bridging. If this is deducted from the cost of bridging, as in the estimate, it brings down the cost of this item to a fairly reasonable figure. The official figures for the cost of this line are of some interest when compared with the previous estimate. They are as follow :—

	Actual figure. dols.	Per mile. £
Land	2,602,000	556
Earthwork	2,541,637	542
Enclosure and fencing ...	17,072	4
Level crossings	112,547	24
Bridges	10,838,051	2,317
Yellow River bridge ...	6,381,230	1,358*
Track	12,948,954	2,766
Signals	924,208	198
Stations	3,937,579	841
Workshops	1,269,236	255
Extra works	238,277	72
Rolling-stock	5,882,570	1,250
General charges	4,967,425	1,062
Extra charges	542,706	116
Police	454,331	97
Director-General	453,395	97
Commission on purchases	1,065,862	227
	55,177,088	11,783†
Interest during construction	9,455,087	
Syndicate	1,399,449	
Exchange	94,397	
	66,126,021	

* Total cost 531,769*l.* † Construction cost per mile.

From this it is obvious that land cost 25 per cent. and earthwork about 50 per cent. more than on the Shantung Railway. These prices were already sufficiently high. Evidently from the amount spent on bridges the methods adopted for the Yellow River bridge were standard throughout the line. It will be observed that the amount expended on track is nearly 1,000*l.* per mile more than as estimated, or about 50 per cent. more. The German rails must, then, have cost on this basis about 12*l.* per ton, or 2*l.* more than the price per ton for girder work from England at the same date. The amount spent on stations is nearly double that in the estimate, and about 200*l.* per mile more than has been expended under this heading on the Peking-Mukden Railway after nearly 30 years' development. No other railway in China has spent anything like this amount in the initial stages. The rolling-stock, which came from Germany, also appears to have cost 25 per cent. more than prices current in the open market. The only economy on the Shantung Railway figures is on workshops.

It would therefore appear that the Germans, while not economical with their own money, were wilfully extravagant, to put it politely, with the funds of the Chinese Government. It should be also pointed out that Germany was mainly responsible for the very favourable terms under which the money for this railway was lent to China. These terms gave to China absolute control of the funds and subordinated the foreign engineers-in-chief to the Chinese director of the railway. They also, as previously pointed out, permitted China to buy in the cheapest market, preference being given to articles of Chinese manufacture irrespective of price. In spite of this, rails were bought in Germany and not from the Hanyan steel works, the property of the Chinese Government; in fact the only foreign supplies not of German origin were the sleepers, which came from Japan.

In connection with the scandals which occurred under the first director, a quotation from an article in *The Far Eastern Review* is rather instructive. It is as follows :—"It has been charged that he (the Chinese director) agreed for a financial consideration to change the terminus of the road, a place near the German concession in Tientsin, and that coal contracts were placed at excessive rates with a colliery controlled by Germans, and that he acted in collusion with German friends in the purchase of lands, sharing the profits with them. He is also charged with employing an undue number of German engineers and assistants at excessive salaries."

Altogether it would appear that German railway morals are rather worse than their commercial morals generally, and that the German record in China in this respect is as doubtful as elsewhere in other fields. In the building of this line Germany had every chance, there was no local opposition of any sort and no difficulties about labour ; Shantung is the labour market of China. The only difficulty was the supply of ballast, and that was merely a question of long haulage. In fact they seemed to have used this concession solely for purposes of exploitation, probably thinking that as Shantung was already virtually German territory, economy with property eventually to be appropriated was entirely superfluous.

With regard to German management, a quotation of the working expenses of the British-controlled Peking-Mukden Line is rather illuminating—

> Peking-Mukden line working expenses, 1915, 7,735,000 dols. ; length, 607 miles.
> Tientsin-Pukow Railway working expenses, 1915, 7,700,000 dols. ; length, 453 miles.

In addition it should be pointed out that the above figures for the Peking-Mukden Line include the upkeep of the largest engineering shops in China at a very slack time owing to the war. The above mileage figures include branches. The Tientsin-Pukow Railway does not pay its way.

It is of some interest to note that the southern section of the same railway, which was built by a British loan, cost 9,100*l.* per mile and traversed far more difficult country. This included the construction of a large terminus on the Yangtze River on a site which was one vast swamp.

CONDENSER AT LOTS-ROAD POWER STATION.

CONSTRUCTED BY MESSRS. W. H. ALLEN, SON AND CO., LIMITED, ENGINEERS, BEDFORD.

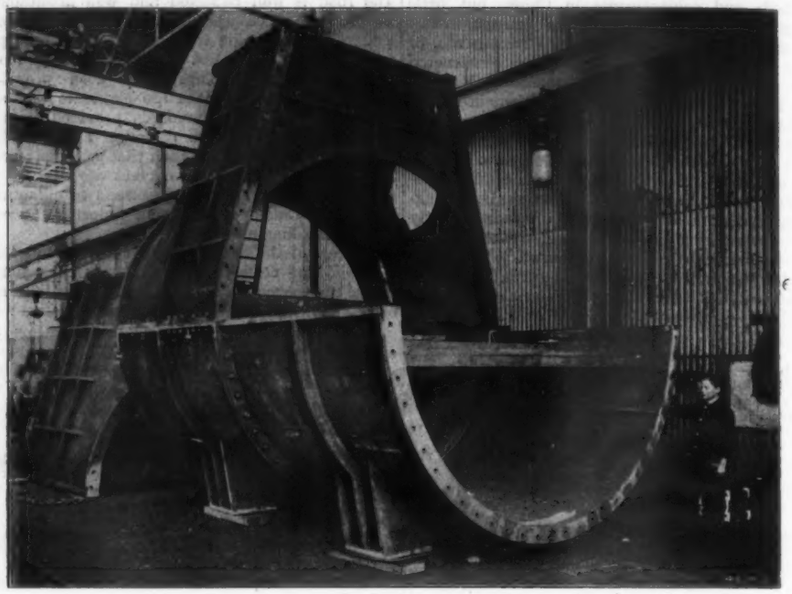


FIG. 38.

15,000 - KW. THREE - PHASE TURBO - ALTERNATOR FOR LOTS - ROAD POWER STATION.

(*Continued from page* 468.)

THE provision of the condenser formed a separate contract, which was awarded to Messrs. W. H. Allen, Son, and Co., Limited, of the Queen's Engineering Works, Bedford. By the terms of the specification the plant was to be capable in normal duty of condensing 180,000 lb. of steam per hour, the makers guaranteeing under this duty a vacuum of 29.1 in. (barometer at 30 in.) with the circulating water supply at 50 deg. F. To avoid the use of abnormally long tubes, or casing of excessive weight, two condensers are provided, through which the steam flows in parallel. The general arrangement of the plant given in Figs. 34 to 37, Plate LV, shows that the condensers are placed transverse to the turbine axis, at 20-ft. centres. Each thus comes directly under one of the two exhaust ports of the low-pressure turbine, which measure 10 ft. by 6 ft., giving a total passage-way for the exhaust steam of 120 sq. ft. It is, of course, essential that the vacuum in the two condensers shall be identical, otherwise an extremely heavy end-thrust on the low-pressure rotor might be developed and cause serious damage. To insure against this contretemps each exhaust branch is connected with the other by the 45-in. pipes, clearly shown in Figs. 34, 35 and 36. One of these balance pipes connects, by means of the 30-in. branch shown in Figs. 34 and 35, with the valve controlling the exhaust to atmosphere, which can be used in case of an emergency.

The general construction of the condenser is best seen in the reproductions of photographs, Fig. 38 annexed, and Figs. 39 and 40, on Plate LIV. The shell has a diameter inside of 11 ft. 6 in. and is (see Fig. 38) built up of four main castings, two of which form the lower half of the shell and two the upper. In view of the high vacuum guaranteed special care was taken to insure the absolute air-tightness of all the joints. The tube plates are of rolled brass 1¼ in. thick, and the tubes are of copper 1 in. in external diameter and No. 18 S.W.G. thick by 14 ft. long. The metal for these tubes was required to assay 99.5 per cent. copper, with from 0.25 to 0.4 per cent of arsenic. The tubes are fixed to the tube-plates by means of screwed ferrules and tape packings, creeping of the tubes being prevented by lips on the ferrules. To ensure metallic contact between the tubes and the tube-

PUMPS FOR CONDENSERS AT LOTS-ROAD POWER STATION.

CONSTRUCTED BY MESSRS. W. H. ALLEN, SON AND CO., LIMITED, ENGINEERS, BEDFORD.

Fig. 41.

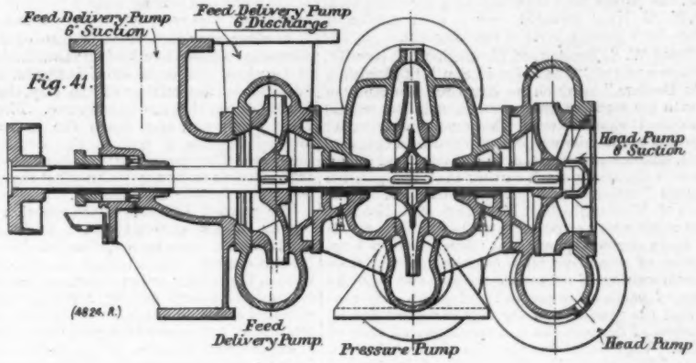


Fig. 42.

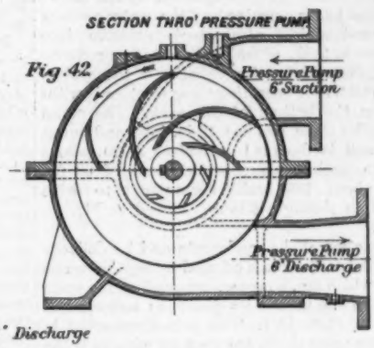


Fig. 44.

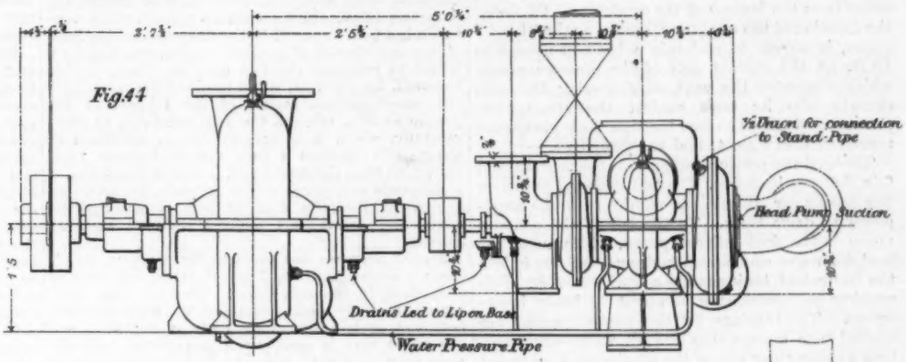


Fig. 43.

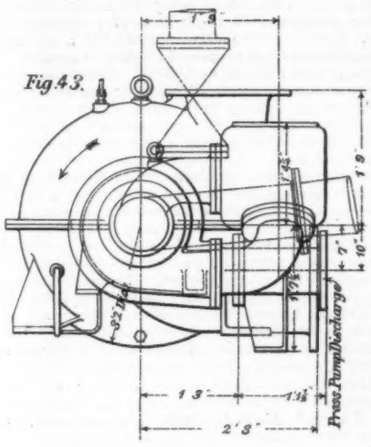


Fig. 45.

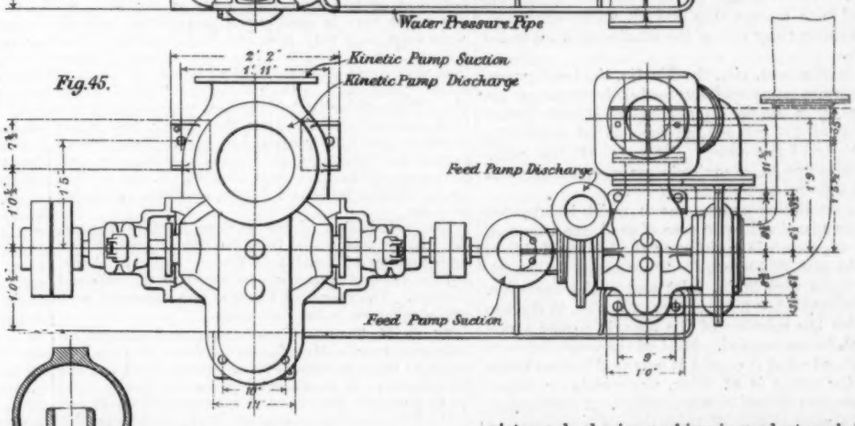
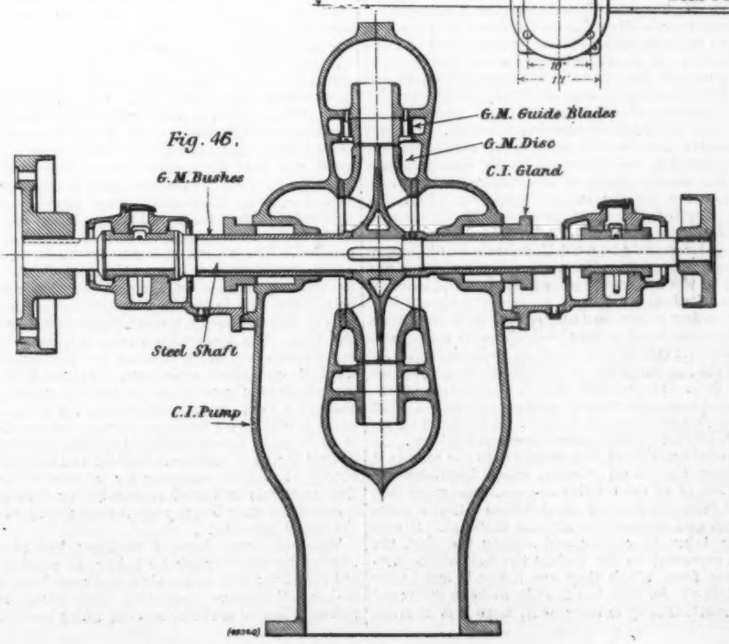


Fig. 46.



plates a lead wire packing is used at each gland. To minimise corrosion aluminium protective blocks are fitted, making metallic contact with the tube-plates. The total cooling surface provided amounts to 15,000 sq. ft. in each shell, making 30,000 sq. ft. in all.

The condenser is built under the Contraflo patents, and the positions of the diaphragms or guide-plates are clearly indicated by the dark lines visible on the tube-plate in Fig. 39, Plate LIV. These diaphragms guide the steam to the collecting space at the bottom of the turbine, and ensure a sufficiently rapid current of steam over the lower tubes to prevent them from becoming air-drowned. Experiment has shown that a tube located in stagnant steam surrounds itself with a jacket of air, which is a remarkably effective insulator and greatly diminishes the rate of heat transmission. The passage-way between the guide-plates diminishes progressively, so that a reasonable steam speed is maintained in spite of the total volume being continually diminished as condensation proceeds. Air is thus prevented from collecting round the tubes, being swept along with the onrushing steam.

The water heads to the condenser are divided up by horizontal diaphragms, so as to give a four-pass flow. The designed flow of circulating water is 10,500

gallons per minute through each condenser, and the water speed is about 6½ ft. per second.

The air pumps are of the kinetic type. A steam jet withdraws the air from the condenser and delivers it to a water-ejector chamber. In this chamber the air, slightly compressed by the action of the steam jet, is entrained by the water ejectors and delivered against atmospheric pressure into the condensate tank, of which a view is reproduced in Fig. 48, Plate LVI. A peculiarity of the system is that the water for operating these ejectors is withdrawn from the bottom of this tank. The pump which supplies these jets has 12-in. inlet and outlet branches and is designed to deliver 3,000 gallons per minute against an effective head of 90 ft., requiring about 108 brake horse-power to drive it. A section through it is reproduced in Fig. 45, Plate LVI.

The extraction of the condensate and its delivery into the boiler-feed tank is effected by another series of pumps, which are, however, arranged on the same bedplate with the kinetic jet pump, as indicated in Figs. 43 to 45, Plate LVI. Two pumps, mounted in series on the same shaft, are used to withdraw the water from the bottom of the condenser. Of these, the function of the one pump, known as the "head" pump, is merely to maintain a head of some 8 to 10 ft. on the suction side of the pressure pump, which completes the work of delivering the condensate into its tank against the atmospheric pressure. Sectional views through these pumps are represented in Figs. 41 and 42, Plate LVI.

The head and pressure pumps have 8-in. suction and 6-in. delivery branches. They are designed to deliver 450 gallons per minute, and require 14 brake horse-power to drive them. To the left of the pressure pump is the feed-delivery pump, which takes the feed from the condensate tank and delivers it into the boiler-feed tank against a head of 37 ft. This requires an expenditure of about 7½ brake horse-power. The bearings for the pump spindles are bushed with lignum vitæ and are water-lubricated, thus avoiding any risk of the admission of oil to the boilers.

All four pumps, viz., the kinetic, the head pump, the pressure pump and the feed-delivery pump, are driven by a single direct-coupled electric motor running at 975 r.p.m. and capable of developing 160 brake horse-power. This is of the semi-enclosed, three-phase squirrel-cage type, and operates with a current supplied at 220 volts.

Two circulating pumps, one of which is intended to serve as a stand-by in case of need, are provided. These are shown in position on the left-hand side of Figs. 34 and 36, Plate LV. They are of the centrifugal type, with 36-in. inlet and outlet branches. As indicated, they have vertical spindles, to the top of which the spindles of the electric motors which drive them are coupled. Most of the weight of each spindle and what it carries is balanced hydraulically when the pump is at work, any excess or defect being carried by ball-thrust bearings. A photograph giving a general view of these pumps is reproduced in Fig. 47, Plate LVI.

Each circulating pump is designed to deliver 21,000 gallons per minute against a total head (including friction) of 56 ft., when running at 485 r.p.m. For this, 450 brake horse-power is required at each pump-coupling, but three-phase motors of 550 brake horse-power rated output have been provided. The two pumps can be worked simultaneously; but, as indicated in the plan view, Fig. 36, either can be cut out of action by means of the sluice valves shown.

The circulating-water supply is derived from the River Thames, through a suction main in the engine-room basement, 45 ft. below floor-level, which we will describe in a later issue. The pressure at this main varies between 12 and 25 lb. per square inch with the state of the tide. The water, after passing through the condensers, is returned to the Thames at a point below low-tide level. The resultant siphon effect reduces the static head against which the pumps have to work from 36 to 16 ft.

(To be continued.)

DEPARTMENT OF INFORMATION.—The address of this office is now Department of Information, Lord Chancellor's Court, House of Lords, S.W. 1.

REFRACTORY MATERIALS SECTION OF THE CERAMIC SOCIETY.

The second ordinary meeting of this section, held on May 21 and 22 at Stourbridge, was again a marked success, the papers read maintaining a high standard. Major H. C. King presided over a good muster of members from various parts of the kingdom.

Professor W. S. Boulton, of Birmingham University, gave an account of "The Clays of South Staffordshire and its Borders," in which he compared the study of clays with the study of igneous rocks, including critical microscopical examination. This examination under high powers of the microscope, combined with chemical analysis, enabled investigators like Bischof and Mellor to advance the study much further than was possible by Seger's "rational analysis." In his work on the fireclays of Northumberland Hutchings concludes that the fine paste which constitutes the basis of the clay is really finely divided quartz and felspar, with a large proportion of secondary mica (sericite) derived from the decomposition of orthoclase felspar, and that the presence of kaolinite is incapable of proof. He contends that the plasticity of the clay is determined by the fineness of the particles and the hydrated state of the mica. Vogt maintains that the plastic substance kaolinite forms nearly the whole mass of kaolin and refractory clays. In the author's opinion some confusion has been imparted to the discussion of the basis of clay and the rôle of kaolinite in clays generally by a failure to recognise the fact that the China clay of Cornwall, for example, is the result of the pneumatolytic decomposition mainly of the felspars of the granite *in situ*, whereas the clay substance in clays generally, which have accumulated as sediments in water, with perhaps a long history between their derivation from the parent rock and their deposition, is a composite substance, which is probably made up in part of kaolinite and in part of the hydrous micas and decomposed mineral residues, such as chlorite.

Special reference was made to the fireclays, which occur in seams, generally 2 to 5 ft. thick, and often as underclays to the coal seams. They are pale grey, brown, or nearly black, tough and unctuous, unstratified, and contain numerous roots of sigillaria, &c. The seams vary in quality and composition, and the same seam may vary from top to bottom as well as laterally. As a rule the lower part is more siliceous than the upper; thus the Old Mine fireclay is "strong" below, "medium" in the middle, and "mild" at the top. The mild or fat varieties are comparatively free from sand admixture, while the strong and sandy varieties pass into ganister-like rock. They are all more or less refractory, some highly so, with a very low percentage of iron, lime and alkalies, and hence their use for making firebricks, retorts, crucibles, glasshouse pots, &c.

The distribution of the various fireclays through the district was traced from the data furnished by a large number of sections of fireclay and coal shafts, and an attempt was made to correlate the different fireclays. The origin of fireclays was discussed with special reference to the local seams.

Mr. G. H. Timmis (Stourbridge) read a paper on "Fireclay from a Manufacturer's Point of View," in which he dealt mainly with the raw material and the getting of it. In the Stourbridge district fireclay is no longer quarried, but mined at all depths down to 350 yards. The necessity of using artificial light adds greatly to the difficulty of selecting the clays underground. Timber and water are also sources of trouble. The Old Mine fireclay was the first seam to be worked locally, and its presence no doubt led to the establishment of the flint glass industry at Stourbridge, owing to its suitability for making the melting-pots. Probably coarser clay of the same seam might be treated mechanically to produce pot clay, but this could not be done advantageously while there is an ample supply of the natural article. Chemical analysis alone is not a guide to the refractory properties, but the rational analysis affords safe guidance.

The fireclay miner has to contend with numerous faults common to all mining, and also with many local disturbances that do not occur in coal mining. By candlelight or lamplight it is difficult to distinguish fireclay from the clunches that lie above and below, and almost impossible to tell good clay from bad when a sudden change occurs at the face. All mining operations are carried on under some piecework system. In the Stourbridge district it is usual to tip the clay as it comes from the pit on mounds, which facilitates the picking out of all the inferior clay and foreign matter, and also thoroughly mixes the clay from different parts of the pit and so provides uniform material. If care has been taken in getting and sorting the clay, the mounds represent on the surface the best of the fireclay seam from which they are derived, but in its future history the clay has usually to bear the brunt of any unsatisfactory development, since it is so much easier to blame the clay than to admit mistakes in the manufacture or use of it.

Clays of similar character in other respects differ greatly as regards their drying properties. Some clays, when made into bricks, unless dried very slowly, harden at the edges and become quite soft in the middle. This peculiarity does not seem to have been investigated.

Another very important feature of fireclay is the shrinkage between moulded size and finished size. This is largely a matter of silica contents, which can be adjusted in the mixing of the clay, but the use of freshly drawn clay has an influence. Fireclay expands after being got, and unless the necessary time be allowed for this to happen the shrinkage seems to increase. The percentage of combined water and carbonaceous matter may also affect the subject, which deserves scientific investigation.

The greatest difficulty of the firebrick maker is the testing of his material under working conditions. Analysis and cone tests are useful, but often fail in practical work. The stresses due to expansion and weight, the cutting action of furnace heat, the mechanical action of dust moving rapidly, or the chemical action of slags and fumes, are inseparable from working conditions, but cannot be reproduced in the laboratory or experimental furnace. Co-operation between manufacturer and user is essential for the adequate testing of new combinations of clays and new processes of manufacture.

Reference was made to the American practice of making firebricks from different grades of clay according to the use to which they are to be put, with corresponding variation in price. This is possible because work is standardised in America. Thus in the case of retort settings a bed of 6's or 8's is the same throughout the country, the retorts being of the same pattern and the division walls being built of purpose-made blocks. Similarly with other furnace work, so that the manufacturer can make and stock with confidence that the patterns will be in demand. Here, however, the manufacturer's stock of ordinary square bricks must be suitable for any purpose for which they may be required, and the special lumps are as a rule not in sufficient demand to justify a departure from the ordinary practice.

In examining large consignments of German-made refractory material the author found that a small proportion for high-grade work was built up synthetically, and was of first-rate quality, but that the bulk of the goods was apparently made from a natural clay, and was of very poor quality, quite inferior to a home-made brick of good class. He concluded by expressing the hope that the Refractory Materials Section of the Ceramic Society may be the means of bringing to the British firebrick manufacturers the co-operation and assistance of the users of their goods.

Mr. W. J. Brooke, of the Shelton Steel and Iron Company, Stoke-on-Trent, read a paper entitled "Refractories for Steel Furnaces from the Consumer's Point of View." He stated that hitherto silica bricks from certain localities only have been considered suitable for the post of danger in a furnace, others from a different source were only entrusted with a lesser degree of responsibility, whilst a third brand could only be allowed to hold lines of communication between inferior positions and the more advanced points. Chemical analysis was usually given as evidence of the quality of the articles, and when trouble arose the furnace manager could only point to his furnace facts, and usually concluded that analysis was no good. To a certain extent he was right, but the scientist never explained to him why. Makers could not understand the troubles, and asserted that the bricks were really good, and that the construction of the furnace must be at fault, or the furnacemen were careless, or the gas was too hot. Eventually they might admit the possibility of their bricks not being perfect, and promise to do better in the future. But no real improvement resulted. The recent enormously increased demand has made it necessary to use almost any likely material for making furnace bricks, and care has apparently been taken in selecting new materials, for the analysis is very little, if any, different from what it was before the war. The results, however, are very different, practically every grade of silica brick being inferior to what it was three years ago. Natural aids to the manufacture of good silica bricks thus appear to have reached a limit, and, looking ahead, it is clear that in order to cut down the cost of repairs to a minimum, so as to meet keener competition when it comes, and having regard to increased demand and limited natural supply, it will be necessary for science to step in, so that materials indicated as suitable by their chemical composition may be properly investigated and used to the fullest advantage.

The intelligent furnace manager has often been puzzled by the very erratic behaviour of silica bricks, not only from different makers but even from the same maker. Excessive expansion sometimes sets up powerful lateral crushing stresses which break up walls

or blocks or roofs. Others run very readily, and at times there is a softening and breaking away of variously sized lumps of the bricks, without any appearance of true fusion. In a roof or crown the bricks may begin to spall when gas is first put in, although the brickwork has been thoroughly dried, and the manager wonders whether total disintegration of the bricks or inversion of the silica will happen first.

Excessive expansion is almost certainly due to imperfect drying of the bricks before burning, or insufficient burning, or both. The remedy is obvious.

The running or complete fusion of the bricks, evidenced on the walls and blocks of a furnace as a very pronounced "smear," and in the roof or crown as "icicles," is always the cause of friction between the furnace manager and the manufacturer, the former blaming the brick and the latter carelessness in the manipulation of the furnace. The carelessness undoubtedly occurs, and the remedy is clear, but faulty bricks also occur, and the remedy is not so obvious. Such defective bricks may be found to contain a relatively low percentage of silica, but not less than that contained in other silica bricks known to be of good quality. Investigation usually shows that in the latter case the difference is made up by increased alumina and in the other case by excess of lime used as bond.

The softening and breaking away in lumps, very often noticed in a roof, is one of the most serious troubles. In one very bad case of this kind no adverse conditions were noticed until the temperature of the furnace was raised to the casting point of the charge. The roof bricks then appeared to soften, and particles of various sizes broke away, without any apparent running of the material, and no spalling, by just a kind of glutinous softening and a quiet disintegration of the bricks. This continued for some time, and at last the furnace had to be put off for repairs after about two weeks' working. On analysis the remaining brickwork showed 96.2 silica, 0.31 alumina, 0.49 ferric oxide, 2.13 lime, a trace of magnesia, and 0.15 alkalies. The texture of the bricks was very coarse, with very finely ground body as a bond. The raw material from which the bricks were made was a very pure quartzite with about 98 per cent. to 99 per cent. silica. Prolonged investigation revealed the fact that the makers concerned, who usually had a very good natural ganister requiring the minimum of foreign admixture to produce a good brick, had in an emergency to make use of another material which was in its natural condition much more refractory, and in order to make a "strong" mechanical brick with this material a certain amount of lime was added. As in their ordinary practice they got good results with a large percentage of coarse particles, the material was ground in the usual way, lime-wash being added in the correct proportion to make up the usual chemical analysis. The result was that while the main body of the brick was of a highly refractory character, owing to the coarse grinding the binding material was distributed through the mass in proportions out of balance with the general average constitution, and the bond, being more fusible than the general structure, melted and carried away with it the more refractory bulk.

Spalling is probably due to the fact that the bricks have not been properly burned, though the material may be coarse or fine, the analysis perfect from the accepted point of view, and everything apparently good. But the silica or quartzite has not been heated enough to produce complete inversion, spalling is caused, and in a similar (though reverse) manner to the spalling of magnesite bricks as described by Dr. Mellor.

The author attributes the continuance of defects in the manufactured bricks to the lack of sound appreciation on the part of both manufacturer and consumer of the application of science and of the systematic research of the scientist.

Reference was made to the steel-making furnace at Sheffield University being available for testing bricks, but the author considers that in addition to Professor Arnold's work at Sheffield there is plenty of scope for investigations to be carried on in other places. Every day hundreds of brick-testing furnaces are in use in this country, and though it may be said that furnace managers are too busy to bother about testing other people's products, yet if it seem likely that an improvement in the product may result, the importance of the subject will find ready and hearty co-operation from them. What is wanted is collaboration of the maker, the consumer, and the scientist, and the author suggests that all the steel makers and refractory brick makers in the country should become members of the Ceramic Society, and, further, contribute to a research fund. The services of Dr. Mellor and his staff would no doubt be available. The plant of some steel works with modern furnaces should be placed at the disposal of the society for carrying out tests of raw material or manufactured products as might be required, such testing to be supervised by representatives of all three interests. The tests would always be made with adequate safeguards and systematic graduation. Makers could submit samples to the scientist, who would in the first instance decide as to the bare possibility of the material proving successful. From the preliminary diagnosis some idea could be gained as to the most suitable tests to begin with. The actual furnace tests could then be applied, and the severity of the tests gradually increased until the limit of the specific refractoriness was ascertained. The tests might take into account varying degrees of texture, density and porosity, chemical constitution, thermal treatment, variations of bond, &c. The results would in the first instance only be communicated to the individual brick maker, but they would be of great value to the maker and user, and finally to the country at large.

For the highest grade of silica brick no doubt the roof of a large steel furnace, with a length of over 30 ft. between blocks, is the best guide. The conditions are very severe on a part of the roof between crown and skewback over the tap hole for a distance varying from 2 ft. to 5 ft. on either side of the transverse centre line of the furnace. In this position all the various defects previously alluded to can be observed, so if bricks found to be satisfactory in other parts of the furnace prove their value here also, they are of the highest quality possible.

Abrasion at high temperatures by the furnace gases, as recently mentioned by Mr. Cosmo Johns, is an important point for investigation. It is almost certain that abrasion in gas ports is due to the velocity of the moving column of gases, which at the outgoing block has to divide into several smaller columns less in area and some areas smaller than others. Abrasion can generally be observed at all points where the moving column or columns receive a check or are made to take a different direction. Abrasion in such cases produces smooth round corners or hollows neatly scooped out, and small evidences of actual fusion may be seen. Probably the gas molecules in the moving column are swept as eddies and swirls, and that, being highly heated, their kinetic energy also plays a considerable part. In "Stahl und Eisen," some years ago, C. Canaris suggested a somewhat similar reason for the greater destruction of brickwork resulting from the use of producer gas rich in hydrogen or water vapour, or both. As the dissociation point of water vapour is lower than the average flame temperature in an open-hearth furnace, hydrogen will combine with oxygen and burn in the cooler parts, and this is in the backs of the outgoing block and regenerator uptakes. This gives a kind of surface combustion naturally destructive to brickwork, and assisting the abrasive action due to the velocity of the gas particles by previously softening the refractory material. Here is a wide field for research by testing various combinations of materials for resistance to abrasion, having regard to composition, texture and bond. As regards the building up of bricks to form a solid structure, it is stated that this is rendered difficult by the variations in size of individual bricks, which in the case of 3-in. squares may vary up to $\frac{1}{4}$ in. over or under the normal size. The corners are absent, the surface exceedingly rough, and they are not square. The senders, in answer to a complaint, point out that by using their cement with the bricks all trouble will be avoided. But even if the cement should be of the same composition as the bricks, it is highly improbable that it has been subjected to the same heat treatment. A good bedding of cement is required to make the irregularly shaped brick lie true, and for this is needed a cement ground up to a thin consistency with water. Joints in places up to $\frac{1}{4}$ in. or $\frac{1}{2}$ in. are common, and that means at least 15 per cent. of the structure is cement. This 15 per cent. has to be converted into brickwork by drying, which leaves the material very porous, and by burning in order to invert the silica. Assuming the bricks to be well burned and of good composition, 15 per cent. of the whole structure has to undergo alteration in volume. When the composition of the cement is not as good as the brick, the result is even worse.

Texture, combined with perfectly homogeneous mixture of the components of a silica brick, demands the immediate attention of makers, users and technical experts.

The chief essentials of a good magnesite brick are, perfect shape and size, fineness of texture, practical absence of porosity, intense hardness, maximum density, and freedom from tendency to hydrate or "fall." The Styrian bricks made by Carl Spaeter and other Austrian makers fulfil all these requirements; they were of fine texture, hard pressed, very heavy, when broken showed a small crystalline semi-vitreous fracture, and when struck gave a ringing sound like a piece of metal.

On one occasion the author obtained a few English-made magnesite bricks from a merchant's stock which were offered with apologies for being undersized; the size required was 9 in. by $4\frac{1}{4}$ in. by $2\frac{1}{2}$ in., and the bricks offered were about $8\frac{1}{2}$ in. by $4\frac{1}{4}$ in. by $2\frac{1}{2}$ in. These bricks were of a pale lemon colour, very square and smooth, of fine texture, with a good ring when struck, and were extremely hard. There was only a trace of iron oxide and alumina and very little lime, and they were evidently made from very pure magnesite. They proved in use to be at least equal to the Spaeter brick. It was ascertained that they were a spoiled lot of bricks, which, owing to a mistake in manufacture, had been "burned." The author had never been able to find the man who made that "mistake."

Fully seventeen years ago Carl Spaeter in his advertisement mentioned the necessity of using high temperatures, and even intimated that the special furnaces in which his bricks were burned had to be made of magnesite bricks. There is no doubt that Spaeter magnesite bricks owed their valuable properties to fine grinding, high preliminary burning, powerful pressure in making the shape, and high temperature in burning the final product. The last-mentioned condition seems to be the most important of all.

If the so-called iron bond is of material advantage, the readiest way of adding iron to the magnesite would be by adding, after the first grinding of the partially calcined material, a suitable proportion of ferrous sulphate in solution, perhaps in the form of waste pickle. When calcined this should give the finest possible admixture of iron oxide.

British magnesite bricks have been very much inferior to the foreign ones, but they are improving, thanks largely to the researches of Dr. Mellor. The scientist and the brick maker have accomplished something by collaboration, and if the user were also taken into consultation with a view to the prompt application of furnace tests under ordinary working conditions, valuable results should be obtained quickly.

The writer based his remarks on what he had seen during many years of practical experience, and the conclusions drawn were as a possible nucleus for the scientist.

Mr. W. J. Jones, of the Ministry of Munitions (Refractory Materials Department), pointed out that British manufacturers of refractory materials were not without reasonable excuses for some of their shortcomings. Thus the production of silica bricks had increased 66 per cent. since the war commenced—from 6,000,000 to 10,000,000. Another point was that the men employed in getting ganister had joined up, and their experience was lost for the present. His impression was that no practical silica brick maker would think of using material containing 98 per cent. of silica. Before the war a few magnesite bricks came from Norway, which were fairly high in silica. Probably the loss of half the weight in calcining might be the cause of no serious attempts being made to manufacture magnesite bricks during so long a period. He cordially agreed with Mr. Brooke's suggestion as to close intercourse between makers, users and scientists. The effort should be national and concerted, and there should be one co-ordinating centre with, say, Dr. Mellor presiding, and other centres in such places as Sheffield, Glasgow, South Wales, Birmingham, each of which should take up different questions for investigation.

(To be continued.)

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has sent us a copy of the new issues, down to No. 27, giving the additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

HONOURS FOR ENGINEERS.—His Majesty the King has been pleased to confer the following honours upon members of the engineering branch of the Navy:—*Distinguished Service Order:* Engineer Lieut.-Commander J. B. Pullblank. *Distinguished Service Cross:* Chief Artificer Engineers H. E. Pope, J. W. Farrow and Henry Taylor; Artificer Engineer W. T. Hall. *Distinguished Service Medal:* Chief Engine-room Artificers J. H. Deacon, John Bryant, J. J. Williams, S. B. Mitchell, W. J. McCleery, W. S. Harrod, James Leighton, Neil Campbell, John Fish, C. W. Thomas, A. E. Jones, A. H. Taylor, T. W. Adamson, P. J. Beer and R. G. Ribbons; Engine-room Artificers H. J. Owen, R. W. Stewart, Herbert Dobson, W. O. Kennedy, W. C. Kingswell and H. A. Drury. *Mentioned in Despatches:* Engineer Commander W. B. Lakeman; Engineer Lieutenants J. B. Hyde and J. T. Barrett; Chief Artificer Engineer F. Smith; Artificer Engineer Andrew Moules; Chief Engine-room Artificers G. F. Redhead, Henry Bell, William Poole, Frederick Baynham, James Galloway, Philip Morrison, G. C. Stalkers, Henry Bradshaw, Nicholas Whitford, W. F. Barrow, H. J. Northey, Alexander Robb, J. M. Dent, Joseph Thompson and John Lightbound; Acting Chief Engine-room Artificer Frank Meachem; Engine-room Artificers James Edgar, Herbert McKay, F. G. Martin, Robert Cochran and D. L. Walmsley.

PERIPHERAL AND BASE-MARKING MACHINES FOR SHELLS.

CONSTRUCTED BY MESSRS. LAURENCE, SCOTT AND CO., LTD., ENGINEERS, NORWICH.

FIG. 1.

FIG. 2.

FIG. 3.

WE illustrate on this and on the opposite page two types of shell-marking machines as manufactured by Messrs. Laurence, Scott and Co., Limited, of Gothic Works, Norwich, and in extensive use in factories where they enable this work to be done by boy or girl workers. One machine is designed for marking on the periphery of the shell, and a perspective view is given of it in Fig. 1, while another is for marking on the base of the shell, and of this two perspective views are given in Figs. 2 and 3.

The peripheral marker is further illustrated by the detailed drawings reproduced in Figs. 4 to 8. The feature is the use of an excentric die roller, in which is cut the required permanent marking on the shell; but apertures are left in this roller for the accommodation of removable characters for marking the date, the lot number, or any such variable notation on the shell. The earlier forms of this marker had concentric rollers, and the weight which applied pressure to the roller was lifted by hand every time the shell was inserted. The excentric roller, however, obviates this necessity, as the shell can be inserted when the marking part of the roller, which is on the part of maximum excentricity, is uppermost, the handle carrying the weight to give pressure at that time pointing downwards, so that the mere action of turning the handle to mark the shell automatically brings the weight into operation. With this device the shells can be marked as fast as they can be fed into the machine, and a girl can work the handle. Two hundred and forty shells per hour can easily be marked. The rollers, even of the removable character, last quite satisfactorily. One roller has been known to mark as many as 40,000 high explosive shells. The wear, of course, is greater in the case of shrapnel, but even here it is not excessive.

The base-marking machine is illustrated in detail in Figs. 9 to 13, two sizes of machine being shown. The marking appliance is secured to the base of the shell by a magnetic cap. Loose dies are inserted through apertures, and the marking is done by the use of a hammer. The dies are prevented from rotating and falling out by means of feathers; otherwise they are loose. The magnetic cap also serves for the lifting of the shell with the usual tackle (as shown in Fig. 2), and the arrangement is such that a boy or a girl can easily mark 60 shells per hour, including the handling.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—A meeting was held at Ashton-under-Lyne, at the Stamford Café, on Wednesday, MAY 23, of the Ashton, Hyde, Stalybridge and district branch of this association, comprising the districts of Ashton, Hyde, Stalybridge, Dukinfield, Guide Bridge and Denton. A committee was elected to further the objects of the association, and it was decided to hold frequent meetings for this object. The association can now count nearly 9,000 draughtsmen as its members. The address of the hon. district secretary is 87, Blandford-street, Ashton-under-Lyne.

THE MANCHESTER STEAM USERS' ASSOCIATION.

THE annual meeting of this association was held at the office, 9, Mount-street, Manchester, on Tuesday, May 22, the president, Mr. Harold Lee, J.P., in the chair.

The report stated that the results of the past year's working had been quite satisfactory, and that the number of boilers under inspection and the revenue were the highest on record. In comparison with 1915 there was an increase of 430 in the number of boilers enrolled, as well as a substantial increase in the income. The net surplus in favour of the year, after making allowance for various items of special expenditure as shown in the statement of accounts, was 758*l.* 8*s.* 7*d.*

During the year the association had superintended the construction and witnessed the hydraulic test of a large number of new boilers, economisers, &c., at the works of the makers, a considerable part of these being on behalf of H.M. Government for use at various war establishments.

With regard to the periodical inspection department also the past year had been an exceedingly busy one, resulting in a very heavy demand being made upon the staff, to which there was a most satisfactory response; attention had been paid not only to the ordinary "thorough" examinations required of the members' boilers, but owing to the war conditions a large number of second-hand boilers and steam or air vessels had also been examined in order to advise as to their safety and suitability for purchase. As justifying the need for inspection it was mentioned that out of 200 second-hand boilers examined the inspectors discovered various defects in 26 of them which led to their being rejected.

The committee point out as a matter of special interest that the conditions which have prevailed for some time owing to the exigencies of the war have led to a number of boiler accidents, due in most part to reliable firemen having been replaced by careless ones, of whom one, at least, continued to fire his boiler for a few hours, although it contained neither water nor steam. Most of these occurrences took place in the case of boilers in charge of men who probably had not yet met the inspectors and had not been sufficiently impressed with the importance and necessity of being careful in the discharge of their work and attendance upon the boilers. Further, the long working hours involved at various establishments and the necessity thus created for the more continuous use of the boilers than in normal times, without the opportunity of internal cleaning, have also been responsible for many boiler troubles, and under the present exceptional conditions the association's system of inspecting and reporting continues to prove its efficiency. It is the association's invariable practice with all boilers under periodical inspection to compare their present with their past condition, and undesirable changes in treatment or condition are thus detected at once and reported upon to the owners.

Outside its ranks the association has noted throughout the United Kingdom during the year the occurrence of 54 explosions, killing 24 persons and injuring 55 others. Of these, 20, killing 13 persons and injuring 18 others, may be termed "boiler explosions proper," while the remaining 34, killing 11 persons and injuring 37 others, may be termed "miscellaneous" explosions, i.e., those arising from steam pipes, stop valves, kiers, stills, drying cylinders, hot water and kitchen boilers, &c.

During the year as many as 10,680 "internal," "flue" and "entire" examinations of boilers have been made, this being the highest number yet reached in any one year. The main object of the founders of the association, viz., the prevention of explosions by careful inspection, has been steadily kept in view, and the committee are pleased at being able to state that no boiler under the association's inspection and guarantee has exploded during the past year.

Since the outbreak of war 18 members of the association's staff have joined H.M. Forces in response to the national appeal, most of whom are at present engaged either in France or in the East, and it is gratifying to the committee that there are no casualties to record beyond those mentioned in the report issued last year.

The report states that "with deep regret the committee have to record, since the date to which this report was made up, the death of two of their number—Mr. Adam Dugdale, on January 20, and Mr. Herbert H. Smith-Carington, on March 3 of the present year. Mr. Dugdale was elected a member of the committee on March 10, 1868, and was appointed president in 1893, and resigned that office in September last only when the pressure of age and health reasons rendered it necessary. Throughout the long period of nearly 49 years he took a very deep interest in the association's work and worthily upheld the aims and objects of its founders. Mr. Smith-Carington was elected a member of the Board on November 21, 1893, and for upwards of 23 years took an active part in its councils. What has been said with regard to Mr. Dugdale's devotion to the association's interests applies equally to Mr. Smith-Carington, and the committee, while recording their appreciation of the services these gentlemen faithfully rendered for so many years, would add their expression of sorrow at the loss of two highly esteemed colleagues."

Mr. Charles Heaton, owing to the state of his health, found it necessary in September last to resign the office of vice-president, but he still remains a member of the committee, to which he was first elected on January 18, 1859, and thus has been a member of the Board for the long term of 58 years. Mr. Harold Lee has been appointed president in succession to Mr. Dugdale, and Mr. Henry Whitehead, vice-president, while Mr. A. Norman Dugdale, son of the late president, has accepted a seat on the Board.

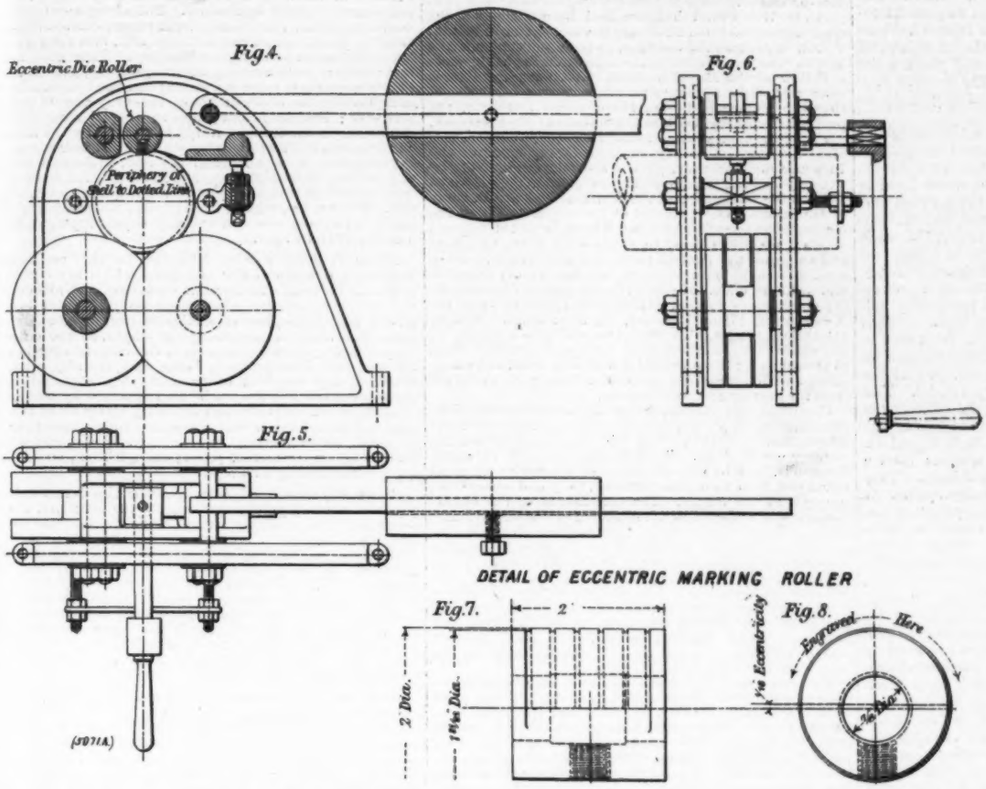
The chairman, in moving the adoption of the report, referred to the loss the association had sustained by the death of Mr. Dugdale and Mr. Smith-Carington. Since the formation of the association in 1854 there had been six presidents, and Mr. Dugdale had occupied the chair for 23 years, the longest period of all.

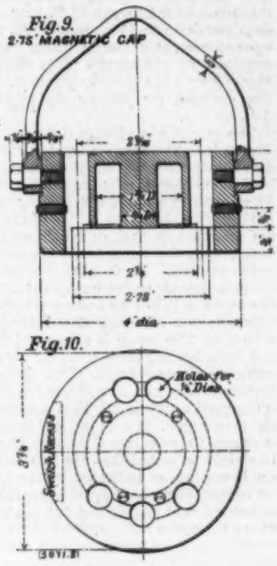
Satisfactory progress had been made during the past year, notwithstanding the abnormal difficulties of the times. The association was not concerned in, nor did it seek, a large extension of business, but it desired that the prevention of boiler explosions and the saving of life and property by careful periodical inspection should be kept in the foreground, this being the object for which it was founded. The association was a pioneer of this principle throughout the civilised world, and it did not seek to give insurance in case of accident so much as an assurance against boiler explosions. No life had ever been lost by the bursting of any guaranteed boiler from any cause

PERIPHERAL AND BASE-MARKING MACHINES FOR SHELLS.

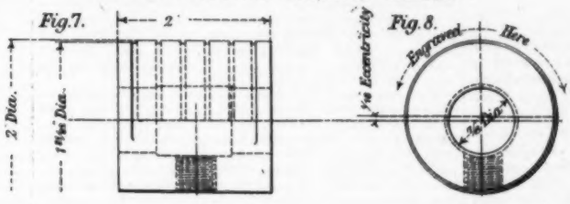
CONSTRUCTED BY MESSRS. LAURENCE, SCOTT AND CO., LIMITED, ENGINEERS, NORWICH.

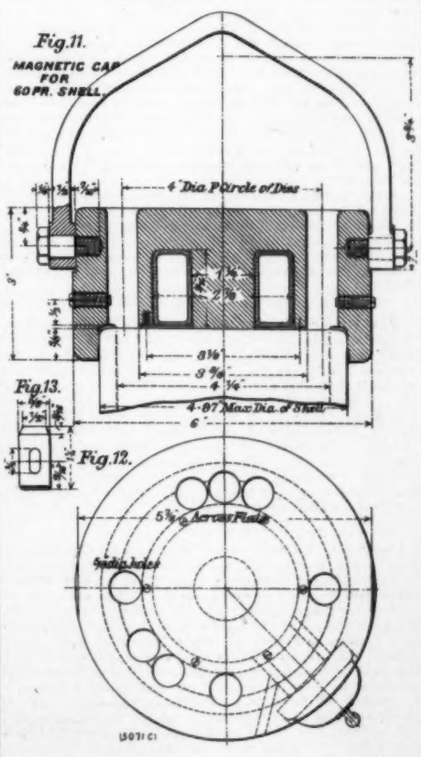
(*For Description, see opposite Page.*)





DETAIL OF ECCENTRIC MARKING ROLLER





which the association could or ought to have prevented by inspection. This was much to say when it was considered how many hundreds of thousands of boilers had been examined during the period of the association's activity. Owing to the great increase of 50 per cent. in railway fares careful inspection was never more costly than it was to-day, but the necessity for the association faithfully to carry on its important work was as great as ever, as boilers outside its ranks still exploded, and the serious defects met with from time to time in the boilers examined showed the value of such inspection by trained men.

The association not only worked for the prevention of explosions, but it had a further object, viz., the attainment of economy in the application of steam. It carried on also scientific investigations for the benefit of all concerned, and he might mention that the investigation of boiler explosions, now conducted by the Board of Trade, was started by the association 50 years ago, the results being for many years published in its monthly reports. Other matters had received attention, such as the construction of boilers, the collapsing strengths of cylindrical furnaces, the effects of water hammer on steam pipes, the strength of flat stayed plates, &c., and this year the strength of corroded plates would be dealt with. Due partly to the mysterious manner in which boiler stays occasionally break, and partly due to the recent repeated failure of screw threads of some large gas engines about which the association's advice was sought, this subject had been carefully inquired into, and the mystery attaching to some of these failures could now be explained.

In conclusion, the chairman, referring to the high number of "entire" or thorough examinations made during the year—the highest on record—said that this careful system of inspection was the safeguard on which the association relied for the prevention of accidents.

Dr. Edward Hopkinson seconded the motion for the adoption of the report, and referred to the fact that the association did not exist for money-making but to prove that boilers could be rendered safe and disastrous explosions prevented by efficient and continuous inspection. The results of 63 years' working proved the soundness of the principle on which the association acted. He had recently paid a visit to India, where there was no similar institution in operation, the licensing of boilers and boiler attendants being in the hands of local governments with the result that the regulations in Bombay, for instance, were quite different from those in Calcutta. Boilers, as he would put it, which might, as it were, be regarded as safe in Lancashire, would be unsafe in Yorkshire, or an attendant who might be efficient in Derbyshire would be turned out in Cheshire; and this brought about a state of affairs which resulted in very great confusion, and in some cases serious consequences. The comparison between the state of affairs in this country and that existing in India was very instructive and showed the real use and the real advantage to the community of such an association as was represented at that meeting.

The speaker referred to the importance of the committee keeping in view the high principles which should always guide the association's actions, and said he was sure that with regard to the new president and also the new vice-president such would be the case. The chairman was the son of the late Mr. Henry Lee, M.P., who was for a considerable time the association's president, and this, together with the fact that Mr. Norman Dugdale, son of the late president, had been elected a member of the committee, afforded full assurance.

The report was adopted, as were resolutions appointing the committee and the auditors for the ensuing year.

THE LATE MR. R. W. GAUNTLETT.—We much regret to have to record the death of Mr. Reginald Wilson Gauntlett, late London office manager for Messrs. Bruce Peebles and Co., Limited, of Edinburgh, which took place on Monday, the 28th ult., at his residence, 31, Clifton-hill, St. John's Wood, N.W. Mr. Gauntlett's large circle of friends will learn of his death with regret, for during his lifetime he deservedly earned the esteem and respect of all who came in contact with him.

THE ONTARIO NICKEL COMMISSION.—The Government of Ontario, Canada, appointed, in September, 1915, a Commission to investigate the resources, industries and capacities of the nickel ores of the province. The recent report by the Commission, consisting of Messrs. G. T. Holloway, W. G. Miller, McGregor Young and T. W. Gibson, states that the nickel ore deposits of Ontario are much more extensive and offer better facilities than those of any other country; the ores are rich and uniform; any of the nickel refining processes now in use could be successfully worked in Ontario; the electrolytic method seems to be the most satisfactory; the refining of nickel in the province would generally benefit the chemical and metallurgical industry of the country. The two operating companies, the Canadian Copper Company, of Copper Cliff, and the Mond Company, of Coniston, have each increased their output without substantial plant enlargement; these companies have not received, nor asked for, any Government assistance. The report deals at some length with the mining taxation of Ontario, which is considered just and equitable. The members of the Commission have themselves experimented, and have taken out, on behalf of the Government, patents for the production of nickel-copper steel direct from Sudbury ores. Two large refining plants are in the course of erection, by the International Nickel Company of Canada at Port Colborn (initial output of 15,000,000 lb. of nickel per annum), and by the British America Nickel Corporation at the Murray Mine near Sudbury (5,000 tons of nickel per annum initially). As regards the processes, the report described the Orford, Mond, and electrolytic (Hybinette) processes, of which, in their opinion, none has any material advantages over the others, though the electrolytic treatment, as mentioned, seems most promising for Ontario; the hydro-electric power conditions equal those of Norway.

HEAVY EDGE-PLANING MACHINES.

On page 524, Figs. 1 to 11, we illustrate a plate-edge planing machine of exceptionally large dimensions constructed by the Covington Machine Company, of Covington, Virginia, U. S.A., for the Standard Steel Car Company, Butler, Pennsylvania, U.S.A. The machine can take a cut 40 ft. long, and can accommodate plates up to 1½ in. thick. As the frames have an open throat, still longer plates can be machined if required, by sliding the plate along and planing the excess length in a second operation. The machine may also be used for planing the edges of angles up to 8 in. by 8 in.

The machine is of very rigid construction, weighing 75,000 lb. The cutting head is traversed by a screw 48 ft. long and 4⅞ in. in diameter, having a double lead acme thread of 1-in. pitch. The cutter head is fitted with two tools, one cutting on the forward and the other on the return stroke of the head, and matters are arranged so that in whichever direction the cut is being made the screw is always subject to a pull and not to a thrust. There is thus not the slightest tendency for it to buckle under heavy cuts. The axial pull on the screw is taken by one or other of two heavy ball bearings, one of which is indicated in place in Figs. 4 and 5. The screw is supported below from end to end by a bearing strip covering about one-third of its complete circumference. This strip is located at the bottom of a trough, as indicated in Figs. 5 and 6. This is designed to retain oil, thus ensuring the efficiency of the lubrication. One of the end sections of this trough is shown to an enlarged scale in Figs. 7, 8, 10 and 11. It should be noted that the two end sections form a single casting, as indicated by the dotted lines. They are subsequently split apart along the central plane. As is perhaps best seen in Fig. 5, a pocket is provided just where the screw ends, and into this is swept any chips carried along by the screw as it turns. These pockets can be cleared out by hand or by a scraper whether the machine is at work or stopped, and each pocket is, moreover, provided with a large drain pipe, through which the oil that collects may be drained off for filtration and re-use. This arrangement also affords facilities for cleaning the screw when desired by flooding the trough with kerosene, which can then be drawn off through the drain pipe preparatory to a fresh supply of lubricant. A washer, Fig. 9, shown in place in Fig. 5, checks the escape of oil along the opening by which the screw shaft leaves the trough, and also the passage of swarf into the bearing.

The cutting head and carriage are of very heavy, rigid construction. The carriage rides on very large way surfaces embodied in the frames, with bronze take-up. The cutting head consists of a very heavy steel casting, mounted in the cross-feed guides on the carriage with two swivel aprons, one on each side of the cutting head. These aprons are pivoted upon the large pin bolt shown on the left-hand end of the apron, Fig. 3, which serves also as a clamp, together with the clamp bolt on the upper right hand of the apron for holding the apron at any desired angle for cutting plates anywhere from a right angle to 60 deg., or, in other words, with a tool adjustment through 30 deg. The tool holders are of the usual clapper-box type used on machine planers, and are large enough to take a tool 2½ in. wide by 2 in. thick, and of any length.

As above stated, a tool is carried on each side of the tool head, permitting the taking of a full cut at the regular speed in both directions, the aprons being adjusted for any particular angle by means of the rack and pinion shown, both aprons moving together. The cutting speed of the machine is 20 ft. per minute, the maximum cut for 1¼-in. plate being $\frac{1}{8}$ in. feed, although before delivery the machine was thoroughly tested with a $\frac{3}{16}$ in. feed.

As indicated in Fig. 2, the machine is motor-driven, and the reversing of the drive of the screw is accomplished by two multiple plate friction clutches. On the motor shaft is mounted a bevel pinion, which mitres into the two bevel gears, which run continuously. The clutches are arranged to grip alternately these gears, to give the motion in either direction, as desired. The motion for reversing the screw through the clutches is taken from the carriage, and the flywheel on the end of the clutch shaft is provided for keeping the carriage in motion after one clutch is thrown out and until another is thrown in. The flywheel further serves, while cutting, to maintain a uniform power on the cut.

The side of the plate which is to be edge-planed rests on rollers and on a table cast integral with the frame. This table is provided with pin-holes against which the plate is set endwise, and the plate is clamped in position by 15 pneumatic jacks, each exerting a pressure of 5,000 lb. when supplied with air at 80 lb. pressure. These air cylinders are mounted on a heavy structural steel beam (see Fig. 1) stiffened against lateral vibration and spring by the use of a heavy channel. The air cylinders are piped up so that all may be thrown in or out of action simultaneously, or any single air jack may be independently operated.

SOCIETY OF GLASS TECHNOLOGY.

At the invitation of the council of the Institute of Chemistry, the May meeting of the above society was held in the rooms of the Institute, Russell-square, London, on the 16th ult. In the absence of the president, the chair was taken by Mr. A. S. Esslemont, vice-president.

After the formal business had been dismissed the chairman called upon Professor Herbert Jackson, F.R.S., F.I.C., to address the meeting, at the same time offering him the congratulations of the society on his being made a Fellow of the Royal Society. These congratulations were singularly appropriate when it was remembered that the honour had been the outcome largely of the professor's classical work in the domain of glass research.

Professor Jackson was received with acclamation, and after bidding the society welcome in the name of the Institute of Chemistry, gave a succinct account of the wonderful work accomplished in glass research since 1914 at the instigation of the Institute and the Ministry of Munitions. One outcome of that work had been the placing of at least fifty new batch formulæ at the disposal of glass manufacturers, to experiment with, to adopt and to improve. Amongst the most important formulæ available could be mentioned batches for (1) resistant and ordinary chemical ware, (2) soft glass for lampwork, (3) combustion tubing, (4) various types of glass for X-ray work, (5) opal glasses, (6) thermometer glasses, (7) optical glasses. To show the widespread nature of the researches already carried out upon glass the effect of almost every known element had been tried, and many glasses with interesting properties were now available both for present and post-war use.

Continuing his address, the speaker complimented glass manufacturers upon the success which had attended their efforts, and spoke of the deep debt of gratitude which the country owes them. By fostering research in many directions, and by the admission of science in its most advanced form into their industry, they had ensured its progress in the future. The enthusiasm of the manufacturer was reflected in the founding of a strong Society of Glass Technology, and the interests of the glass industry at large were being well served by the glass technology department of the University of Sheffield and by the numerous representative committees set up by the Ministry of Munitions. The outlook for the future was most encouraging and promising, for numerous interesting problems were needing attention, whilst new ideas and new methods all required testing. The glass industry was a striking example of the co-ordination of the manufacturer and scientist at its best.

The professor then passed on to a most instructive discourse upon the properties of glass, dealing first of all with the relation between hardness and temperature of founding and leading up to brittleness and the amorphous nature of glass. The causes of crystallisation were pointed out, and the analogy between well-known crystallisation phenomena in pure chemistry and in actual glass manufacture was emphasised. In particular the necessity for homogeneity was commented upon. Given good homogeneity many of the problems of annealing and faulty metal would automatically disappear. A most instructive lecture was concluded by the recounting of many new facts dealing with opal glasses and colour in glass, whilst lines on which research could be carried out were indicated. Not the least pleasing feature of the lecture was the telling way in which the interdependence of science and industry was demonstrated, and members of the society fully appreciated the limning of the science and art of an old and beautiful industry by a master of his craft.

Prior to the above meeting the members of the society paid a most enjoyable visit to the works and show-rooms of Messrs. Powell and Sons, Ltd., Whitefriars.

The next meeting of the society will be in June at the University, Sheffield, when a joint discussion on refractory materials has been arranged with the Faraday Society.

The Brier Hill Steel Company's New Plant.—We read in *The Iron Age*, New York, that the Brier Hill Steel Company, Youngstown, Ohio, which hitherto has produced only pig-iron, billets, sheet bars, black and galvanised sheets, has decided to erect two plate mills. One of these will be a 32-in. by 84-in. tandem mill, to roll plates up to 72 in. wide, and the other a 38-in. by 132-in., three-high mill, to roll plates up to 120 in. wide. Contracts for these mills and their equipment have been placed with the United Engineering and Foundry Company, Pittsburg, and it is hoped to have the mills ready for operation in ten months to a year from the time active work is started.

Chemical Manufacture in France.—As regards dichromate, France had, before the war, been dependent on England and Germany; some 3,000 tons of dichromate were being imported annually. The new works at Ponthierry (Departement Seine et Marne), compete with England and make 500 kg. of sodium dichromate per day; this sodium salt does not crystallise well, being more soluble than the potassium salt, and was hence at first supplied as a concentrated solution; but a crystallised product is now obtained, we see from *l'Industrie Chimique* of April last. Potassium permanganate is made at Château-Ponsac at the rate of 100 kg. per day; the output, like those of the products, is to be much increased; the same works also manufacture the golden sulphide of antimony, which had been prepared on a small scale in the north of France. Another chemical industry of Northern France, that of potassium carbonate and other potassium salts from the residues of molasses distilleries, has been taken up at Choisy.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—Little change in connection with affairs in the steel-making industry falls to be recorded—every establishment doing Government work, both old and new alike, being constantly employed in the production of an output which seems to become more phenomenal as the days go on. The newly constructed works, as well as the additions and extensions to already existing plant, have come well into line, and the results are considered eminently satisfactory. Plate mills and bar mills are alike running at full pressure, but of this output nothing is available for export, the home market still having the superior claim to every ton of steel produced; the only exception to this is some small shipments to France and Italy as required by the allied Governments. Steel of every description, finished and semi-finished, is in abnormal demand, and shell bars, shipbuilding shapes and sections, and general standard sizes cannot be turned out in sufficient quantity to meet this. For export, what little there is, prices are still a matter of arrangement, frequently depending upon the position of the works.

Malleable Iron Trade.—Business in the malleable iron trade remains at the high level which has characterised it for some considerable time now, and although the recently arranged restrictions on its export have placed larger supplies of malleable iron on the home markets, even this goes no great length, as the entire output is very speedily absorbed, the demands for both the iron and steel products being exceptionally heavy. Sales of any material other than that required for purposes of the war cannot be contemplated by makers, as at the moment their chief difficulty seems to be their inability to deliver within scheduled time the supplies required, either directly or indirectly, by Government. Could this be overcome, prices, though high, could be quite satisfactorily arranged.

Scotch Pig-Iron Trade.—So great is the demand for pig-iron of every grade, and notably for hematite, that producers are straining every nerve to increase the available supply, a proceeding fraught with much difficulty on account of the continued irregularity of the deliveries of ore. All brands, more especially No. 1 foundry iron, are occasionally subject to a certain scarcity so that any accumulation of stock is quite out of the question; but, with export practically a sealed book in the meantime, this shortage is not nearly of so much consequence as it would be in normal times. No shipments are being put through. Firm rates still rule, no change having taken place.

Government Appointment for Clyde Shipowner.—A new appointment has just been made by the Shipping Controller, Sir Joseph Maclay, which should do much towards lessening the submarine menace in so far as coasting shipping is concerned. To Mr. Hector M. MacNeal, of Messrs. Mann, MacNeal and Co., Limited, shipowners, Glasgow, has been allotted the task of transhipping all cargoes arriving by large liners in their first home ports for other destinations. The entire control of this branch of the shipping trade will be in Mr. MacNeal's hands, a circumstance which will be eminently satisfactory to all concerned.

Sulphate of Ammonia.—Some interesting facts relative to the manufacture of sulphate of ammonia and its use as a fertiliser were publicly made known at the annual meeting last week of the Broxburn Oil Company by Sir Archibald McInnes Shaw, chairman of directors. He stated that for a number of years now the Scottish oil companies and the gas companies throughout the United Kingdom have been large producers, while within more recent times the coke-oven industry has added greatly to the production. Prior to the war the annual consumption in Great Britain was only about 130,000 tons, but now this has risen to something like 435,000 tons, a very substantial increase, for which the Government's advocacy of its use as a fertiliser is mainly responsible. In time it is expected that the entire production will be absorbed by home consumers.

Foreign Trade Catalogues.—We have received from the Commercial Intelligence Branch (Foreign Samples Section), Board of Trade, 32, Cheapside, E.C., a copy of the index to foreign catalogues issued by German and Austro-Hungarian firms, which have been collected by this Department from all parts of the world. The catalogues in question may be seen by United Kingdom manufacturers at the above address, and, in certain cases, where it is not convenient for manufacturers to inspect the catalogues in London, they will be lent for short specified periods, so that firms may have an opportunity of studying them at their own works.

The Late Mr. Alexander Gibson.—We regret to have to record the death, which occurred on Saturday, May 19, of Mr. Alexander Gibson, B.Sc., F.R.G.S., late senior chief cartographer at the Admiralty. Mr. Gibson was well known in the circle of scientific interests concerned with geographical and cartographical work, and had been a distinguished occupant of the official position referred to, from which he retired in 1914, after 40 years' service at the Admiralty. When the war broke out he was recalled to continue his services, and was at work until a few days before his death. Mr. Gibson's long and continuous service at the Admiralty had made him an unequalled authority upon the charts of the coasts and waters of the world, both British and foreign, and owing to his great capabilities for critical examination and research he contributed many important records of high value to the work of accurate chart construction.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—In spite of the holiday at the large works, there is a persistent demand for all grades of manufacturing fuels. This is in a measure due to the practice of works in building up reserves upon every conceivable opportunity. Exports to Allied Powers are on consistently heavy scale, but those to neutrals are falling away week by week. Household requirements are on an increasing scale and are more nearly approaching winter trade than summer business. The bulk of the people who have any storage accommodation at all are taking the advice of the authorities and storing, but dealers are not able to provide them with the full quantity they desire. Most of the pits have been idle during Monday and Tuesday, and in most cases only a fairly satisfactory start was made this morning. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.*, per ton at the pit.

Iron and Steel.—With most of the works on holiday from two to three days, business in the raw material market over the week-end has been almost at a standstill, and there are few features of interest. The gradual stiffening of the deliveries is still perceptible, though big efforts are being made to expand output in a more rapid fashion than has hitherto been the case. There is an increased call for scrap, which is attributable to the growing scarcity of iron. Steel makers have all their work cut out to meet contract accounts, and furnaces are working at full stretch to produce all that is wanted. It is difficult to get anything at all in the steel line unless the work is classed A by the Ministry of Munitions, and apart from this grade there is a falling-off in the amount of steel available. Agricultural engineers are making bigger demands than was at one time thought likely, but this is accounted for by the increased requirements on the part of farmers for all classes of labour-saving devices which will be of use during the harvest season. Shell discard steel is selling briskly at 11*l.* 10*s.* to 12*l.* per ton, but this is principally bought by trades which are not classed in the national importance category. Overseas trade continues on a good level, with recent indents for tools of all varieties, hammers, knives, anvils, engineering work, wirework, saws, files, hardware, cutlery, plates and steel.

ON THE TAXING OF INDUSTRY.—In the course of an article on the fairness which is due to the industry of the nation, *The Iron Age*, New York, states that the framers of tax legislation have planned to get a large income for the Government by heavily taxing all war activities. They have failed, adds our contemporary, to give due weight to the large sacrifice of men which the war may impose on the present generation, and to the high costs of all necessaries of life which will rule throughout the war—from both of which the generation following the war will be exempt. They have underestimated also the debt those who come after will owe the present generation for so colossal an undertaking on behalf of humanity. Thus, therefore, the plan to raise by taxes what might better be carried forward in large part in the form of loans. Strongly arguing against this plan is the certainty that the industries, if too heavily taxed, cannot prepare to meet the demands which will be made upon them after the war. They are prosperous now, but unjust taxation would curtail their prosperity. That fact is being appreciated in the threshing out of tax proposals in Congressional committees.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—The first district general meeting of the Tees-side and Hartlepools branch of the above association was held in the Literary and Philosophical Institute, Stockton, on Saturday, May 19, and was attended by a large and representative body of draughtsmen. The chairman, in his opening remarks, dwelt briefly on the very satisfactory progress made since the introduction of the association in the district, and commented on the admirable manner in which the various local branches had organised and co-operated towards making it a complete success. In his report the secretary stated that there had been a steady influx of members; in the majority of the localities contained within the district over 80 per cent. of the draughtsmen had become members. The president, in the course of his inaugural speech, touched upon the urgent need of some such organisation as was now formed, and he felt that at last draughtsmen had taken a definite step in the right direction. It would, he thought, be generally conceded that draughtsmen were, of necessity, a very highly trained and efficient body of men, of proved mental ability, and undertaking tremendous responsibilities; and when one considered the years of hard work and study involved in order to attain this state of efficiency, it was not by any means surprising that they at least expected just, if not generous, treatment. The drawing-office staff formed the hub in every engineering works, and the ultimate success of any works was in direct ratio to the ability and energy of that staff. Whilst draughtsmen have always responded to the calls made upon them, he could not, unfortunately, say that they had received a corresponding recognition of those services. There was not the slightest reason for the continuance of this condition of affairs, and every effort should be made to end it.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—The market is quiet, holidays having interfered with business this week, but deliveries of Cleveland pig-iron to consumers who can be reached by rail continue on quite a satisfactory scale. There is no dearth of pig-iron, and the June allocations to home users, and to customers in Scotland, promise to be equal to all legitimate requirements, and it is also gratifying to have the assurance that means of distribution are adequate to needs. Shipments are stated to be improving, and further negotiations are proceeding for contracts with France and with Italy. Demand on Italian account is very good. For home consumption No. 3 Cleveland pig-iron, No. 4 foundry, and No. 4 forge are all quoted 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; and for shipment to France and Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.*

Stocks of Cleveland Pig-Iron.—Stocks of Cleveland pig-iron are small. Quantities lying at makers' yards and consumers' works are no more than are necessary for current needs, and there are now only 1,879 tons in the public warrant stores, 1,873 tons being No. 3 quality, and 6 tons other descriptions deliverable as standard.

Hematite Iron.—There is no new feature in the East Coast hematite branch of the iron trade. Supplies to home users are well upheld and are adequate, whilst occasional new business on home account is reported, but there is little surplus iron available for shipment to buyers abroad, and as sellers are more disinclined than ever to enter into foreign transactions on the recognised market terms, export quotations are quite nominal. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 142*s.* 6*d.* for export to Italy.

Coke.—There is hardly so much passing in coke as there has been, but the demand is still very considerable, and values are not weakened by the more than ample supply. Fixed maximum rates still rule for descriptions needed for the blast-furnaces, and prices of other qualities keep firm. Average blast-furnace kinds are 28*s.* at the ovens, and low phosphorus sorts are 30*s.* 6*d.* at the ovens. Best foundry coke runs from 41*s.* to 42*s.* 6*d.* for prompt delivery, and patent oven coke is quoted 40*s.* and upward for forward delivery. The gashouse product is in the neighbourhood of 30*s.*

Manufactured Iron and Steel.—Little new is ascertainable concerning the various branches of the finished iron and steel industries. Pressure for delivery continues heavy, but manufacturers are coping well with the enormous demands of the Government, and the very extensive and still steadily growing needs of the shipyards. Quotations all round are strong. To home customers, common bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

Output of Cleveland Ironstone.—An important conference has been held at the Ministry of Munitions this week between representatives of that Government Department and deputations from the Cleveland Ironstone Mine Owners and the Cleveland Ironstone Miners' and Quarrymen's Association, with regard to schemes for substantially increasing the output of ironstone. The miners urge that to achieve the object of the Government the men who have enlisted from Cleveland mines should be returned to the industry, and that if outsiders are to be introduced they shall become members of the miners' association and be governed as to wages and conditions by the agreements between the mine owners and the miners.

DISTRIBUTION COSTS.—The politician who denounces the excessive freight charges of the railways is always certain of a sympathetic hearing, even from auditors who may themselves be employing in their warehouses or factories the most antiquated and expensive methods of handling and transporting the materials delivered to them by rail. A report recently issued by the United States Census Bureau is of interest in this connection. It deals with cost of distribution within the City of Washington, D.C., and indicates that delivery of living necessaries within a city costs more than railway freight transportation. One of the 128 mercantile establishments in that city reported 6.2 per cent. of the gross sales was spent for delivering. Grocery delivery costs were 4.4 per cent.; milk, 12.1 per cent.; bakery products, 19.8 per cent.; ice cream, 14.9 per cent.; ice, 45.6 per cent.; coal and wood, 15.2 per cent., and laundries, 20.3 per cent. The estimated total costs of freight and intra-city delivery amounted to 40 dols. for each individual last year, of which slightly more than one-half was for cartage. The report expressed the belief that the figures apply approximately to delivery expenses on articles for retail consumption in other cities. Secretary Redfield said the report showed "that the factors in the cost of distribution which we may group into the word 'cartage,' are more costly and more important than railway freight rates, and that this subject has almost been ignored in our public thought. It is one of our largest wastes, but seems to go almost unheeded by students of public matters.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The decision of the miners to take three days' holidays this week has naturally affected the market. In view of this fact it was anticipated that there might be a shortage of supplies, and for this reason towards the end of last week there was a strong undertone. Buyers, however, were averse to doing business on the basis of 30*s.* for late May deliveries, but for immediate dispatch the prices were easier. For early delivery bunkers were quoted round about 16*s.* 6*d.* and cargo sorts from 9*s.* to 14*s.* There were heavy outputs during last week-end, with the result that there was a considerable increase in the quantity of coal standing on the sidings this week, and the arrival of tonnage has not been sufficient to reduce the stocks to the extent anticipated. For the moment interest is centred almost exclusively on the conditions of the new Government scheme for the regulation of prices. Anxious inquiries are being made for official details, but a state of considerable uncertainty prevailed as to the exact price for the different classes of coal. It is, however, known that the Government have decided to make very considerable changes, and some of the anomalies which obtained under the old limitation scheme will, it is confidently asserted, be removed. All business for forward shipment is just now subject to the conditions of the new scheme, and quotations, though remaining unaltered, are really nominal. Several points are being discussed. It is not clear, for example, how far bunker coals are included in the scheme, but it is felt that their exclusion would mean the creation of needless anomalies.

Newport.—With the collieries idle, very little business was done this week, and, as at Cardiff, interest centred almost entirely on the minimum prices which have been determined upon by the Government for the regulation of the coal export trade. The official announcement is expected momentarily, but pending this announcement buyers and sellers are adopting a non-committal attitude.

The Supply of Pitwood.—Pitwood is still scarce, and is quoted on the Cardiff market at 75*s.* per ton. The Monmouthshire and South Wales Colliery Owners' Pitwood Association, Limited—an organisation brought into being really at the suggestion of the Government—has made extensive arrangements for the supply of home-grown timber. The concern has now a membership of 91 collieries producing approximately 40,000,000 tons of coal per annum, or four-fifths of the total output of the South Wales collieries. About 200 men are being employed in felling timber in different parts of the country, and very considerable woods have been acquired. Those concerned with the management, however, are being hampered by official rules and regulations. Mr. Finlay A. Gibson, the secretary, gives quite a catalogue of instances. At almost every point, he states, there is a clash of administrative authority. The following are among the instances given:—When an application was made to the Priority Department of the Ministry of Munitions for the necessary machinery the reply received was that such a certificate could not be given, but that separate application must be made for all new machinery. The Petrol Committee could do nothing in the direction of providing petrol for the use of transport appliances except on the recommendation of the Home-Grown Timber Committee, and when that committee was communicated with it required complicated details of machinery, mileage, &c. Even when the petrol licence was eventually secured it was found to be inoperative without the sanction of the Petrol Pool Board, and notwithstanding pressing letters and telegrams motor lorries have been kept idle for days. The Home-Grown Timber Committee directs wagons to the woods and the Owners' Association makes arrangements to load them, but then the transport superintendent steps in and states that empty wagons must not be sent but drawn from the nearest depots. These examples could be multiplied, but they are sufficient to show the difficulty of dealing with departments in London who are not cognisant of local conditions and necessities.

AMERICAN IRON AND STEEL EXPORTS.—Whatever gains the German submarines may have made in the destruction of the commerce of the Allies during March, the immense operations of the Teutons, says *The Iron Age*, made no impression whatever upon the United States exports of iron and steel during that month. Our contemporary then gives the following figures in gross tons:—For March, 1917, 606,560, as against 438,150 for March, 1916.

ATMOSPHERIC POLLUTION.—Owing to the importance of the work undertaken by the Committee for the Investigation of Atmospheric Pollution and the advantages likely to result from obtaining a continuous record from year to year of the state of the atmosphere as regards suspended impurity, the committee has been constituted an "Advisory Committee on Atmospheric Pollution" to the Meteorological Office, and a grant of 500*l.* has been allotted by the Department of Scientific and Industrial Research to cover the cost of the work for the current year. The grant is intended to defray the expenditure of the Advisory Committee only, and was given on the understanding that the cost of gauges, collection and analyses should be borne by the authorities which co-operate by setting up observing stations. Provision has also been made for the nomination by each co-operating authority of a person for appointment as a member of the Advisory Committee. Full information as to method of working, with standardised instructions and blank forms for returns, can be obtained from the honorary secretary, Dr. J. S. Owens, 47, Victoria-street, London, S.W. 1.

HEAVY PLATE-EDGE PLANING MACHINE.

CONSTRUCTED BY THE COVINGTON MACHINE COMPANY, ENGINEERS, COVINGTON, VIRGINIA, U.S.A.

(*For Description, see Page* 522.)

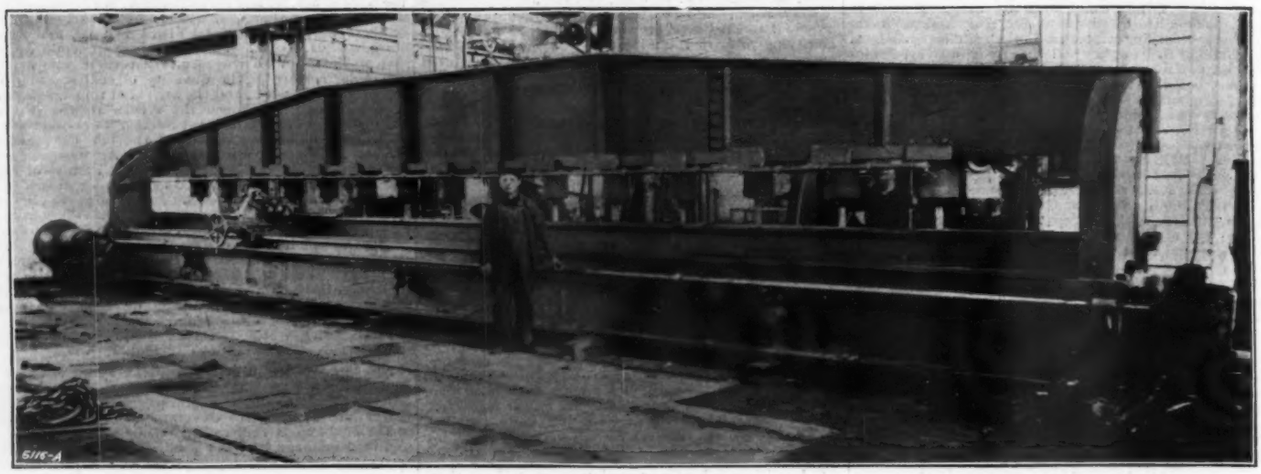
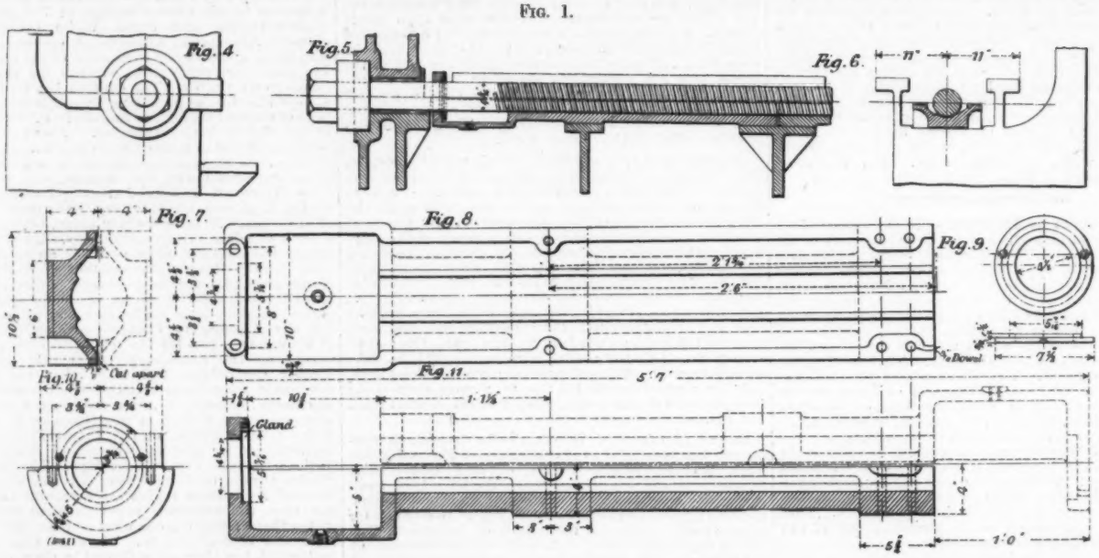


FIG. 1.



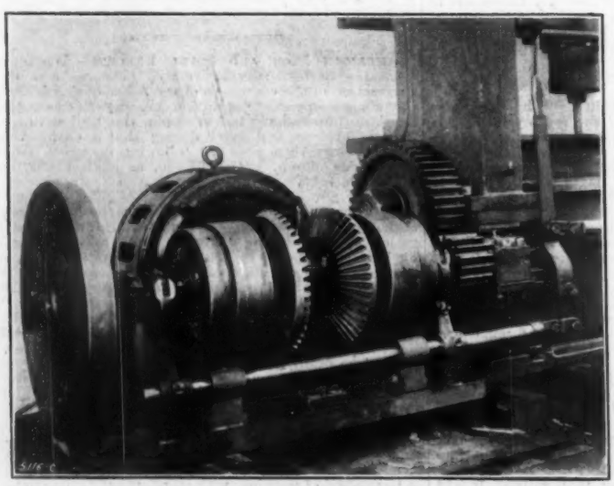


FIG. 2.

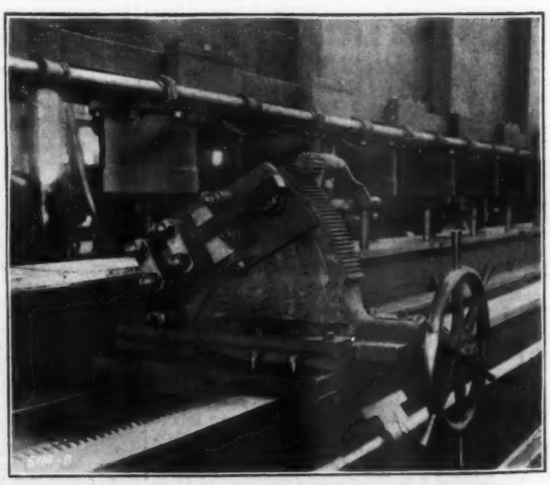


FIG. 3.

CONDENSERS FOR 15,000-KW. TURBO-ALTERNATOR AT LOTS-ROAD POWER STATION.

CONSTRUCTED BY MESSRS. W. H. ALLEN, SON AND CO., LIMITED, ENGINEERS, BEDFORD.

(*For Description see Page* 516.)

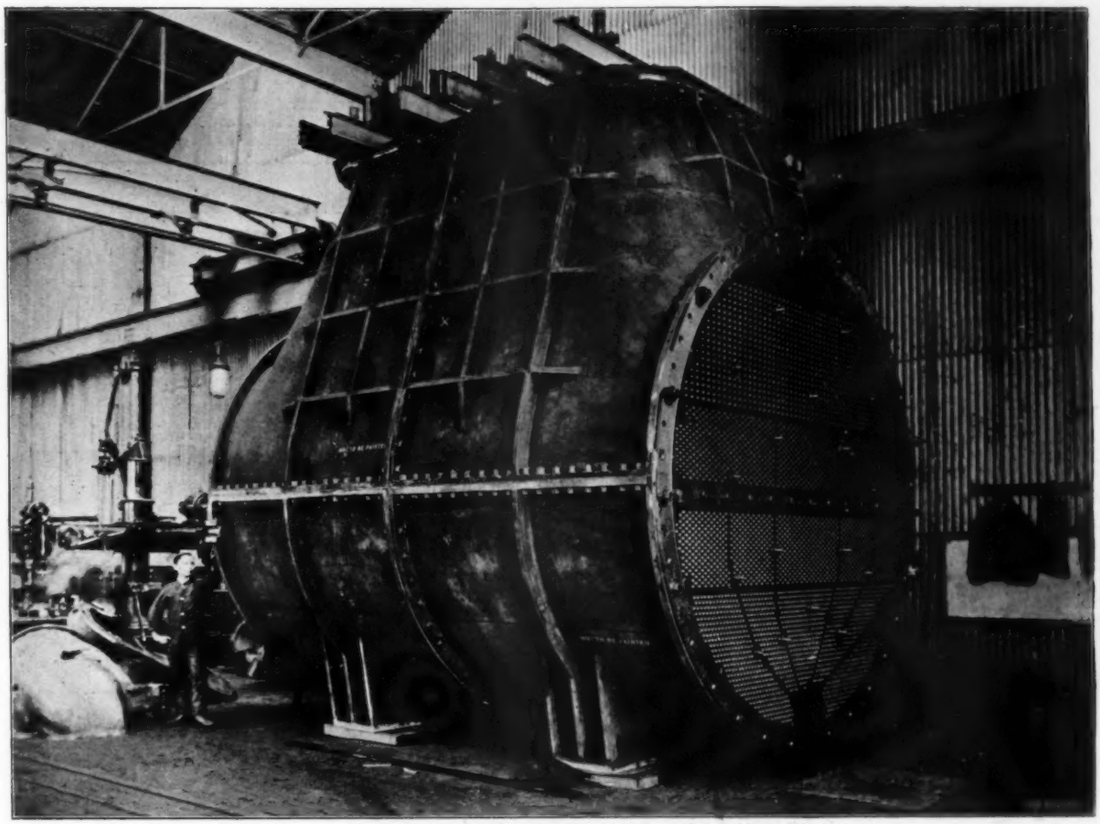


FIG. 39. VIEW OF ONE CONDENSER SHOWING TUBE-PLATE.

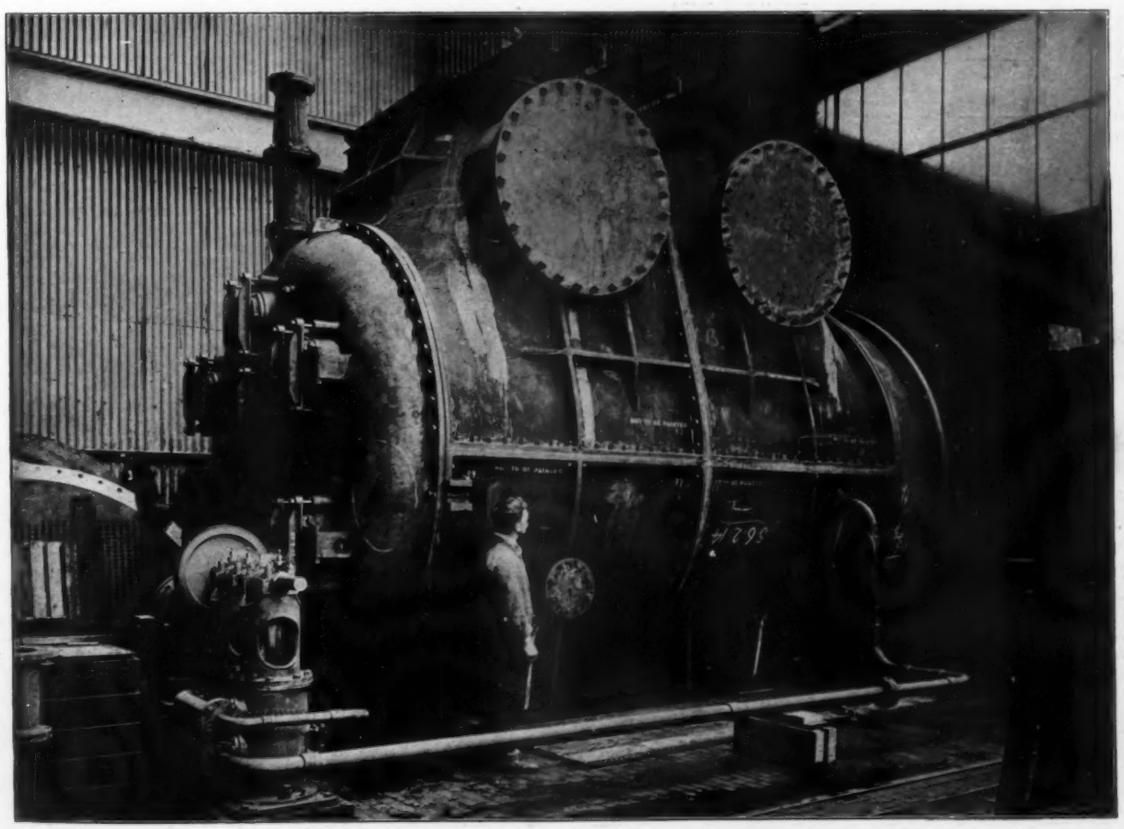


FIG. 40. VIEW OF ONE CONDENSER COMPLETE, SHOWING FLANGES OF BALANCE PIPES.

(*To face page* 516.)

CONDENSERS FOR 15,000-KW. TURBO-ALT

CONSTRUCTED BY MESSRS. W. H. ALLEN, SON AND CO., LIMITED, ENGINEERS, BED

(For Descri

Fig. 34

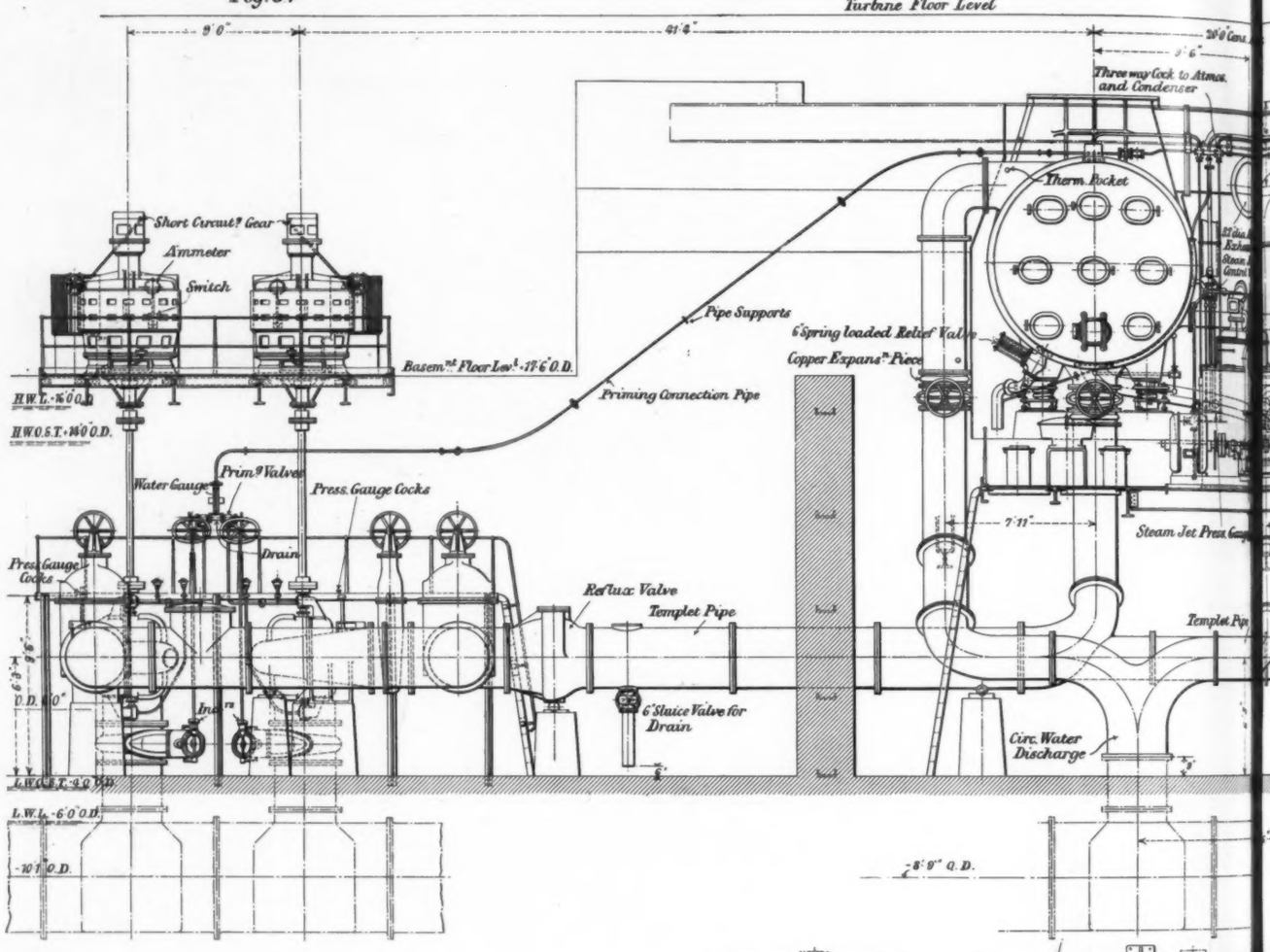
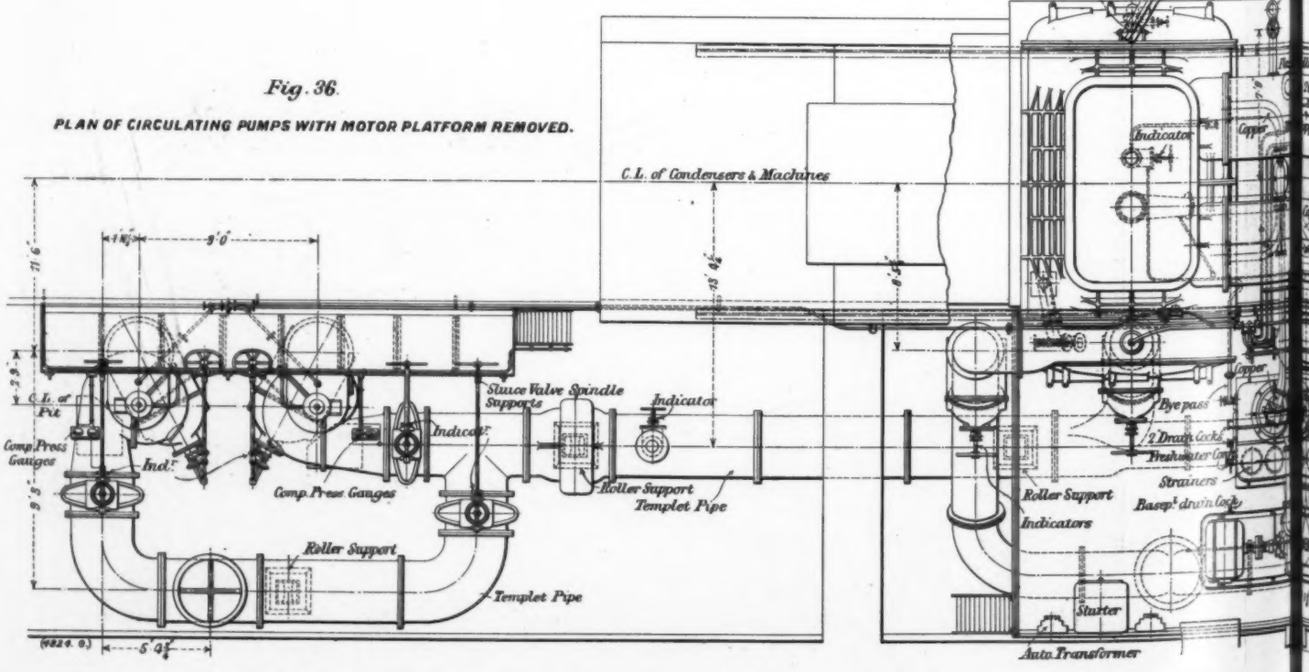


Fig. 36.

PLAN OF CIRCULATING PUMPS WITH MOTOR PLATFORM REMOVED.



D-ALT NATOR AT LOTS-ROAD POWER STATION.

ERS, BEL ; MESSRS. MERZ AND McLELLAN, CONSULTING ENGINEERS, LONDON AND NEWCASTLE.

(For Descrip ge Page 516.)

Fig. 35. SECTION THRO' A.A. WITH WALL REMOVED.

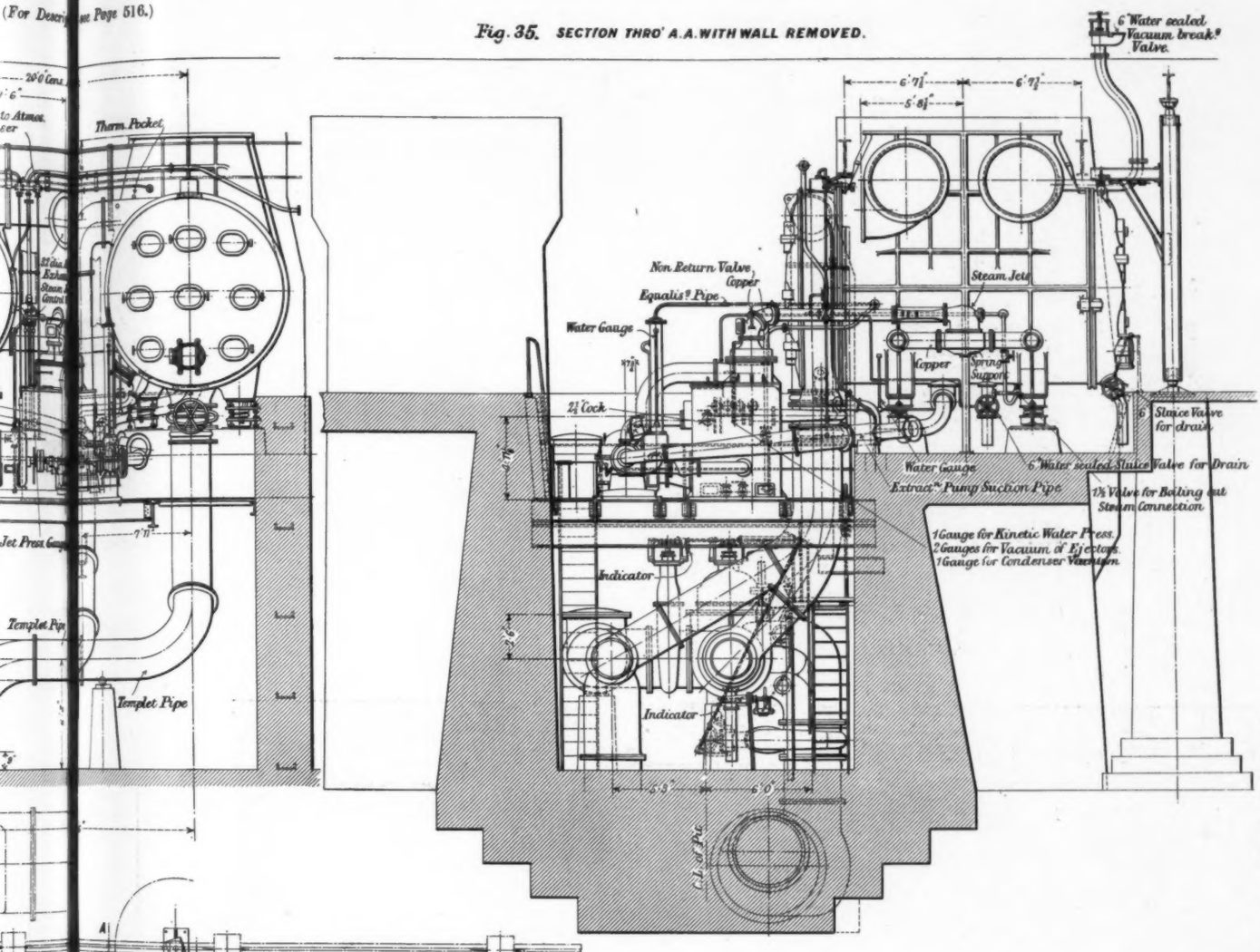
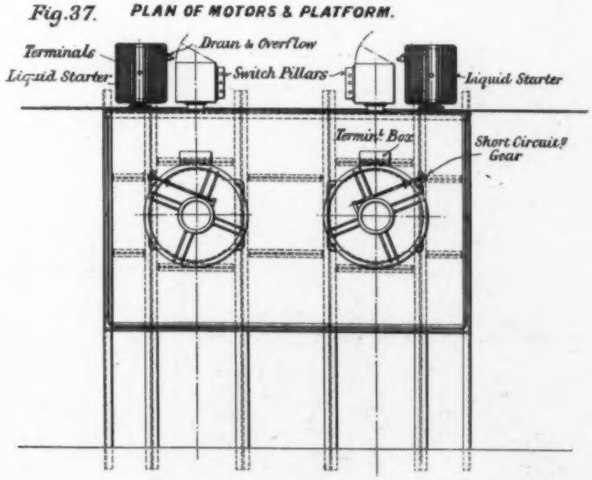


Fig. 37. PLAN OF MOTORS & PLATFORM.



CONDENSERS FOR 15,000-KW. TURBO-ALTERNATOR AT LOTS-ROAD POWER STATION.

CONSTRUCTED BY MESSRS. W. H. ALLEN, SON AND CO., LIMITED, ENGINEERS, BEDFORD.

(*For Description, see Page* 516).

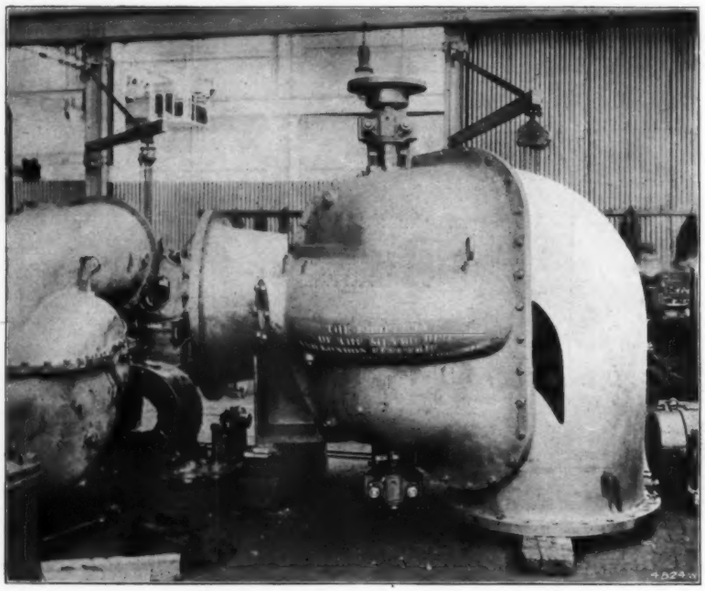


FIG. 47. CENTRIFUGAL CIRCULATING PUMPS FOR CONDENSERS.

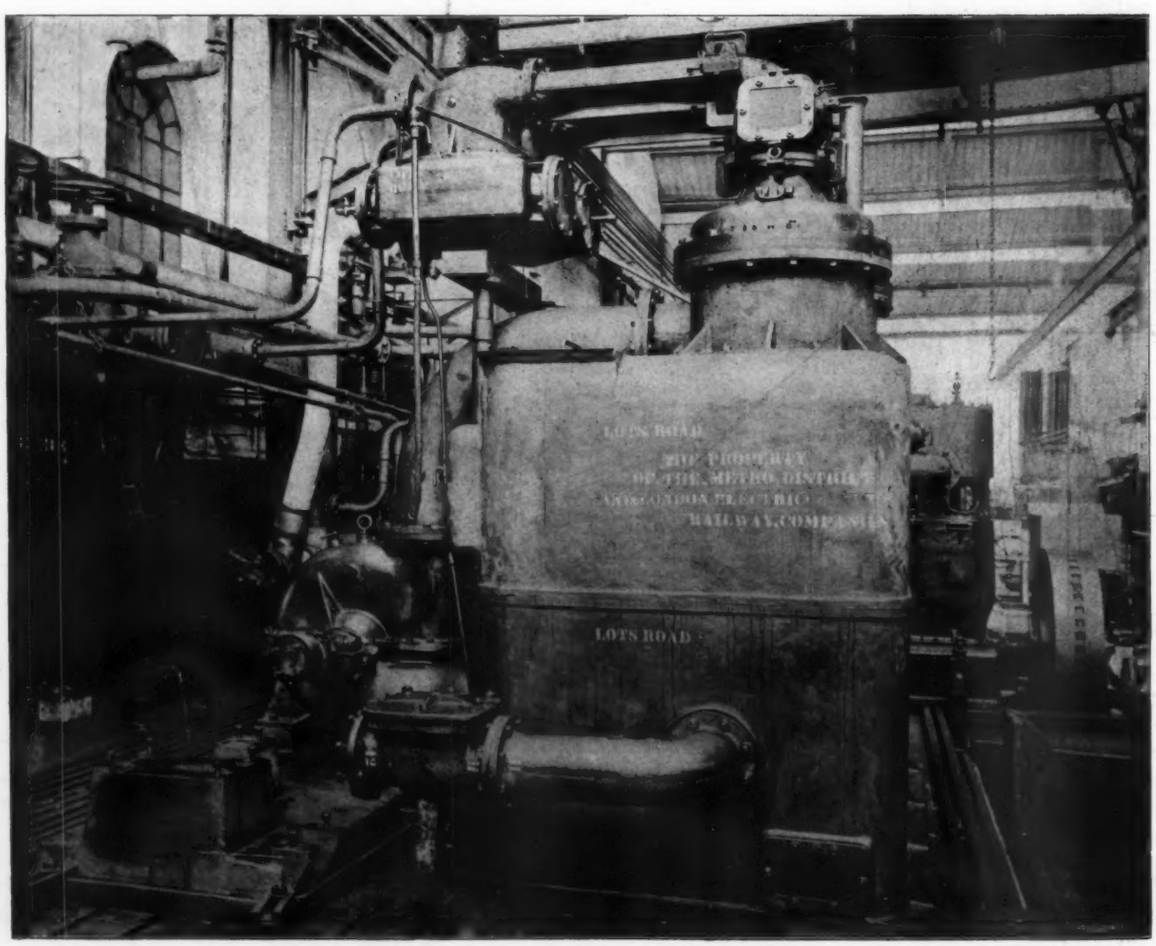


FIG. 48. KINETIC TANK FOR CONDENSERS.

(*To face page* 517.)

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ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£2 4 6
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Thin paper copies	£2 0 6
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All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3633 and 8568 GERRARD.

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With One Two-Page Plate and Two One-Page Plates of CONDENSERS FOR 15,000-KW. TURBO-ALTERNATOR FOR LOTS-ROAD POWER STATION

NOTICES OF MEETINGS.

THE SURVEYORS' INSTITUTION.—Monday, June 4, at 5 p.m. The annual general meeting of the Institution, to receive the Report of the Council and the announcement of the result of the election of officers for the ensuing year, will be held.

THE RÖNTGEN SOCIETY.—Tuesday, June 5, at 8.15 p.m., at the Cancer Hospital (Free), Fulham Road, S.W. Annual general meeting. Discussion on "The Future of the British X-Ray Industry" (adjourned from the last meeting) will be continued by Captain R. Knox.

THE SOCIETY OF ARCHITECTS.—Thursday, June 7, at 6.30 p.m., at 28, Bedford Square, London, W.C. 1., when a paper will be read on "Coal from Concreted Breeze, Sawdust and Ashes," by Mr. R. Goulburn Lovell, A.R.I.B.A., M.S.A.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, June 8, at 5.30 p.m. A discourse will be delivered by Professor Sir J. J. Thomson, O.M., LL.D., D.Sc., Pres.R.S. The subject is "Industrial Applications of Electrons." Afternoon lectures next week at 3 p.m. Tuesday, June 5. Professor W. W. Watts, LL.D., Sc.D., F.R.S., on "The Flow of Ice and of Rock—the Flow of Rock" (Lecture II), (The Tyndall Lectures). Thursday, June 7. Mr. Arthur C. Benson, C.V.O., LL.D., on "The Art of the Biographer" (Lecture II). Saturday, June 9. Professor Sir J. J. Thomson, O.M., LL.D., D.Sc., Pres.R.S., Professor of Natural Philosophy, Royal Institution, on "The Electrical Properties of Gases" (Lecture VI).

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

ENGINEERING.

FRIDAY, JUNE 1, 1917.

CHANGES IN THE PERSONNEL AT THE ADMIRALTY.

PRACTICALLY all the Government departments have long since undergone reorganisation, with a great increase in the personnel. That the Admiralty have passed through nearly three years of war without any corresponding changes is indicative, in the first place, of the efficiency of the conditions prevailing during peace time and of the facility with which they were adaptable for war; and, in the second place, of the strenuous and effective work done by the chiefs and members of staff of the respective departments. It is not prudent to indicate the enormous additions made to the fleet and the continuous growth in the current work accomplished since August, 1914, whether as regards the maintenance of existing ships in service condition under the serious stress of watching the enemy or of occasional engagements. The increase in new construction, when it can be revealed, will form one of the most surprising features in connection with war operations. The current demands and prospective requirements have been met, on the part of all responsible for the matériel of the fleet, with a loyalty and devotion consistent with the traditions of the Admiralty.

It is not surprising that some method of strengthening the constructive department has now had to be devised. Nearly every official has been over-stressed for a long time, and it was felt that some system of devolution was necessary, similar to that long ago carried out at the War Office, by the creation of the Ministry of Munitions and other departments. The old position of Controller—who was primarily responsible for matériel—has been revived after a lapse of some years, during which the work was undertaken by the Third Sea Lord of the Admiralty; and a novel step has been taken in appointing to this office a civilian in the person of Sir Eric Geddes, whose administrative ability has proved effective in several other land war service departments. For special reasons there has been conferred upon him the honorary and temporary rank of vice-admiral, as he will be much engaged in supervising the work of officers of the executive and engineering branches of the service. Sir Eric, according to the official announcement, "will be responsible for fulfilling the shipbuilding requirements of the Admiralty, War Office and Ministry of Shipping, as far as possible, by manufacture or purchase, whether at home or abroad. For this purpose the staffs of the three departments which relate to these requirements will be placed under his control." A new Deputy Controller has been appointed, and here the Admiralty have been happy in their choice, as the position is to be filled by Mr. Thomas Bell, who has been for many years connected with the management of the Clydebank works of Messrs. John Brown and Co. For many years he was engineering manager, and for a long time past managing director of the whole establishment. He has brought to bear on this work great organising ability, technical experience and decisive control, so that he has just those qualities which equip him for his responsibilities in connection with the Controller's department of the Navy—"for all matters appertaining to the construction of warships, and the maintenance, alteration and repairs of warships and armed merchant cruisers, both at the Royal Dockyards and by contract." Major-General A. S. Collard, C.B., R.E., who was Director of Inland Waterways and Docks in the department of the Director-General of Movements and Railways, has been appointed a Deputy Controller for Auxiliary Shipbuilding, and will be responsible for all matters connected with the design, construction and purchase of merchant ships, and of all auxiliaries to the fleet, whether required by the Admiralty or other Government departments; the repair of these fleets will also come under his control. Sir Vincent L. Raven, the Chief Superintendent of Ordnance Factories, is to be Deputy Controller for Armament Production, including guns, torpedoes, mines, &c. The Naval Assistant to the Controller is to be Acting-Captain Thomas E. Crease, C.B., while the Civil Assistant is Mr. J. A. C. Champion. These, with subsidiary appointments, constitute a strong "controlling" board.

The ship constructional departments have also been under review. Sir Eustace H. Tennyson D'Eyncourt, K.C.B., continues to hold the office of Director of Naval Construction, and remains the Principal Technical Adviser on Design. Mr. W. J. Berry, hitherto an assistant director of naval construction, is to be the Director of Warship Production responsible to the Deputy Controller for Dockyards and Shipbuilding "for the economical and expeditious construction of warships of all kinds by contract, including the hull, armour, electrical apparatus, equipment and fitting."

As regards work in the dockyards, Sir James B. Marshall, K.C.B., Director of Dockyards and Dockyard Work, has retired. For quite thirty years he has been identified with the department, and after being for many years Assistant Director of Dockyards was appointed Director of Dockyards in 1906. His time for retirement on the age limit was reached a year ago, but he was requested then to continue in office because of his great administrative ability and his firm grasp of the immense detail of the department. He agreed to continue, and now has earned his retirement even under present war conditions. The new Director of Dockyards and Repairs is Rear-Admiral Laurence E. Power, C.B., M.V.O., who has been for many years superintendent of contract-built ships. He has displayed great ability as an executive officer, but it is an innovation to appoint to this post a military officer. He is to be responsible to the Deputy Controller "for dockyards and shipbuilding, for the general management of dockyards, and for the economical and expeditious performance of work therein, including the construction, alteration and repairs of warships, and their machinery, electrical apparatus, equipment and fittings." Another officer who, in the constructional department, has done much useful service for the Navy, and who had passed the age limit, is Mr. W. H. Whiting, C.B., Superintendent of Construction Accounts and Contract Work. He also had been requested to continue in office owing to the war, and he also retires with the knowledge that he has done splendid work for the Admiralty. His department will be

partly merged in the already-mentioned directorships, principally that of Warship Production.

As regards the engineering branch, Sir Henry J. Oram, K.C.B., who became Senior Inspector of the Engineering Department of the Admiralty in 1894, Deputy Engineer-in-Chief of the Fleet on the reorganisation of the engineering staff of the Admiralty in 1902, and Engineer-in-Chief in 1907, has retired, having almost reached the normal age of retirement from the public service. During his tenure of office of Engineer-in-Chief greater progress has been made in naval machinery than in the preceding fifty years. It is well known to the engineering projession that to Sir Henry belongs a large part of the credit of introducing the water-tube boiler into warships, thus rendering increase in power possible without forcing the boilers. He was a strong advocate of the use of oil fuel, which is so much lighter than coal and can be fed into the boilers without manual effort, gives greater power per unit of weight, lessens the time required in renewing supplies, and obviates trimming as with coal. He also was instrumental in introducing the turbine to supersede the reciprocating engine, which could not take any overload at crucial moments, as is now the case with the turbines of our warships when the enemy ships appear on the horizon. The power of the propelling machinery on board many of the ships to-day is many times that of ten or fifteen years ago, and yet there is the most gratifying immunity from breakdowns or defects. Sir Henry has been strenuous and devoted in service, and he retires with the full satisfaction that he has left his impress on naval engineering, and that his originative work has been of incalculable service in the maintenance of Britain's sea power during the war. Rear-Admiral Goodwin's succession to the highest post that the naval engineer can reach will give great satisfaction not only to the engineers of the service, but to all who, as Admiralty contractors, are closely associated with that department. Possessing the same qualities as his predecessor and colleague, he is certain to maintain the great success achieved in the recent past. Engineer Vice-Admiral Goodwin, to which rank he has now been promoted, entered the service early in life, and took a first-class professional certificate at the Royal Naval College, Greenwich. After serving some time in the department of the Engineer-in-Chief of the Admiralty, he put in sea service, and was next attached to the staff of the Director of Dockyards, becoming later Chief Engineer of the Chatham Dockyard. In 1906 it was decided to appoint an engineering assistant to the Director of Dockyards, and the then Captain Goodwin was chosen for this post, where he continued until his appointment in 1907 as Deputy Engineer-in-Chief of the Navy.

One or two other appointments have been made: Colonel H. Livesey, R.E., Deputy Director of Inland Waterways and Docks, has been appointed Director of Contracts during the absence of Sir Frederick W. Black, K.C.B., at present a Director-General of Munitions at the Ministry of Munitions; Lieut.-Colonel J. G. Boharrel, Assistant Director-General of Movements and Railways, is now Director of Statistics; and Lieut.-Colonel R. S. Horne, K.C., is a Director charged with all questions relating to the supply, distribution and allotment of raw materials.

We are less concerned with the changes made in the personnel consequent upon the decision to have a naval staff commensurate with the immense responsibilities in respect of strategic and tactical movements of the fleet. But it is well to show that in this, as in the construction department, changes have been found necessary owing to the development of the war. Admiral Sir John R. Jellicoe, G.C.B., C.M., G.C.V.O., as was announced recently, in addition to being First Sea Lord, is now Chief of the Naval Staff, the former Chief of the Staff, Vice-Admiral Sir Henry F. Oliver, K.C.B., M.V.O., being Deputy Chief. Rear-Admiral Duff, C.B., takes the title of Assistant Chief; his former work in charge of the Anti-Submarine Division of the War Staff justified this appointment. Moreover, he now becomes an additional member of the Board of Admiralty. Rear-Admiral Tudor, C.B., has retired from the position of Third Sea Lord, becoming Commander-in-Chief of the China Station, and is succeeded in his position by the former Fourth Sea Lord, Rear-Admiral Lionel Halsey, C.B., C.M.G., but, as has been pointed out, the constructional work formerly undertaken by the Third Sea Lord passes directly to the new Controller's Department, of which Sir Eric Geddes is the head. The new Fourth Sea Lord is Rear-Admiral H. D. Tothill, C.B. The official announcement indicated that these changes were, first, to free the First Sea Lords and the heads of the naval staff, as far as possible, from administrative work, in order that they might concentrate their attention on the important issues relating to the naval conduct of the war. At the same time the process of strengthening the naval staff by the addition of officers transferred from active sea service is being continued. The second object is to strengthen the Shipbuilding and Production Departments of the Admiralty, by providing an organisation comparable to that which has supplied the Army with munitions. Further, it is intended to develop and utilise to the best advantage the whole of the shipbuilding resources of the country, and so far as possible to concentrate the organisation under one authority.

EQUALITY OF LABOUR DILUTION.

THE ability of women to do work that was previously exclusively done by men has been one of the outstanding revelations of the war. It is an unsuspected national asset, which for immediate purposes is second only in importance to the discovery of almost universal military virtue in our peace-trained and peace-loving population. The country's resources are strained, although not beyond their strength if properly utilised. There is urgent necessity for the complete use of all the resources that we have; and those who are familiar with the engineering trades from within know that the national asset of women-power is not being used either completely or even nearly so.

Much can be truly said of the compensating advantages that dilution should bring. In output, now vital in the most real sense to the nation's forces, experience has shown that on the whole the change should yield a welcome increase. Sir William Beardmore has recorded the result of the experiment that he made when the employment of women was less general and their use in substitution for men a bolder and more enterprising step than it is now; and the gain of output that he got from substituting women for trained mechanics has been verified repeatedly by those who have followed in his footsteps. As the recent exhibition of the Ministry of Munitions has shown, there is now practically no operation within a woman's strength, whether in repetition or non-repetition work, that women are not doing to-day in one works or another; and the limits of that strength—limits wholly compatible with their health and well-being—have turned out to be far wider than any engineer would have suspected. The benefits that the industries may expect to derive from their employment are, moreover, not confined to the gross gain of output. To secure that gain the new labour has had to be used in closer accordance with the laws of true economy than has been customary in the employment of men. The relative inexperience of women has made it necessary that the difficulties which they have to encounter in their work should be faced in detail and in advance by those who employ and instruct them; and where present workers have acquired painfully and slowly a mixture of manipulative skill and manipulative error, women have had no opportunity for picking up manipulations that they ought to unlearn, and what they do is done in the unmitigated best form that their instructors have been able to teach. The abundance of work, if not in one article, at least on one machine or one process, has enabled them to be working at full efficiency as soon as they have mastered a single machine or process, without waiting to acquire the greater versatility of an all-round tradesman. The need for getting the best output and maintaining it, and perhaps to some extent the attentions of Sir George Newman's Committee on the Health of Munition Workers, have led to the introduction into works where women are employed of devices for saving fatigue and increasing comfort that were unthought of before; and though no great attempt seems hitherto to have been made to solve the problems of intermission of work, which are probably among the most important of the undetermined data of intensive production, a start has been made on them here and there.

All the modifications of works practice induced by the employment of women may be expected to enure ultimately to the benefit of men, and of the whole industries in which such first principles of efficient production have been applied. Yet for the present it would be throwing dust in our own eyes to pretend that, except in the direct benefit to the women themselves, the dilution of engineering work by their substitution for men is anything but a sacrifice to all concerned. It is one part of the mechanism by which the nation in its supreme need is claiming the services of its citizens; and all men, rich and poor, skilled and unskilled, should be equal when the share of each is apportioned.

The sacrifice that is asked of engineers is no more than is being made by all classes of their fellow-countrymen; and it would be made by them cheerfully and willingly if they were convinced of its need, and if it were asked of all alike. Unhappily, the present system fails to give them these essential assurances. A man knows that he is needed for service outside his trade, a works manager knows that he has to arrange to part with his men, if and when the man's work can be done as efficiently by a woman or women. But up to now no test, either present or in prospect, has been announced either to men or to managers by which they can know in advance for themselves whether the man's work is replaceable or not. The question, with its grave personal issues to the man and its wide anxieties and responsibilities to the manager, is left to be solved by the next inquiry that the Ministry of Munitions may be pleased to hold into the circumstances of each individual works. No man and no manager can tell which works will next be investigated or reinvestigated; nor, when the inquiry comes off, is there any concrete standard by which the parties so deeply interested can judge whether they ought to be taken or left. Much must at present depend on the view held by the individual inspector on whose report the Ministry acts; and with the large number of such inspectors who are employed up and down the country it is difficult to imagine that a uniform view can pervade the Ministry's staff of the interpretation that should be put on a given set of circumstances; or, indeed, that the whole of this great staff can have even approximately a uniform competence to form a correct opinion, or an equal ability and disposition to stand by it when it has been formed. In circumstances so uncertain, with the extent of dilution left to be settled without the help of accepted standards, as the resultant of an inspector's opinion varying in competence from district to district, and a works manager's arguments and insistence which probably vary as much from works to works, it is not strange that trades, men and masters, regard the extent of dilution to be required of them as still in the lap of the gods, and their attitude to the change is often determined by their sense of the inequality with which it is enforced.

To be plain, as in a matter of this consequence a responsible journal must be, the Ministry of Munitions in its dealings with the dilution of labour has reversed the old motto, and has done not *multum* but *multa*. With admirable insight and perseverance, for which all credit is due to its technical staff, it has pursued the possibilities of dilution into the remotest and least likely branches of manufacture; and in all essential branches of work that can conceivably be done by women it has accumulated convincing evidence that women can do and are doing it. But it has not had the courage of its convictions. Possessed of this information, of which it showed probably some thousands of examples at its exhibition, it has stopped short of drawing from it the practical inferences by which the best dilution could be uniformly assured, and has left them to be drawn by each separate works, under the haphazard pressure of the Ministry's staff and correspondence. In such a procedure it has doubtless fallen into line with the weary practice of older Government departments; but it has not yet

assumed the position that belongs to it in this matter, or begun to discharge the responsibility that it has undertaken. It has brought dilution into works as a proprietary article is pushed, to be taken up, here more and there less, without any known standard to regulate the extent of its adoption. It has not acted as the technical headquarters of the united munitions industries of the country, which is the function that in this connection it is plainly expected to fulfil.

On the assurance of equal dilution depends the conviction of men and masters that dilution is really necessary and their willingness to undertake the sacrifice that it involves. A works that sees its neighbours or its friends in another district retaining on work similar to its own a much larger proportion of men will not realise that the country's needs requires it to put up with a less proportion, even if it were prepared to submit to the injustice of having to bear a greater share of the burden. The Ministry of Munitions has shown what dilution can do; and no doubt is possible that uniform standards could be set up, if it would have the courage to come out into the open and declare them. For each essential industry it has proved that, not as freak performances but in the routine of practical and efficient manufacture, certain machines and manual operations can be used and performed by women on certain classes of work. It has shown equally that the training which suitable women require for making an efficient start on the large majority of these machines and operations takes only a few weeks. The wide publicity that it has given to its exhibition shows that it is confident of a sufficient supply of women and instructors. If these facts mean anything, they mean that the Ministry could specifically define these machines, operations and classes of work, and require that after fixed dates all firms alike should restrict each of them to women, saving only where under exceptional circumstances a special licence had been granted to employ men. If the estimated yield of such a measure exceeded the number of men who are required, the restriction for all firms alike could be limited to a corresponding percentage of the total. These measures, or others equally definite, comprehensive and impartial, seem to be the plain administrative consequences of the facts, if the men are to be obtained from the shops and the sacrifice involved is to be distributed fairly.

In introducing dilution hitherto the Ministry has, in fact, addressed manufacturers as though its officers were so many factory inspectors, each having power to negotiate a separate Factory Act for every works that he visited. If it would now address the munitions industries as a body of engineers speaking to engineers who are looking to it for the truth on an essential part of their work, it would receive from them the support that the discharge of its duty would deserve. While it merely invites each of them to draw inferences on dilution that it is afraid itself to express in administrative action applicable equally to them all, works will too often continue to do what they can to avoid or minimise dilution. If such a result were merely a departmental failure it would perhaps be of no great consequence in these times. But if—as no sane man can doubt—the need for men is what the Government says it is, and to lack men means to prolong the war, the crippling of dilution through the Ministry's failure to define it would be an act of bureaucratic cowardice; a breach of trust, entailing an awful responsibility.

THE ELECTRICAL PROPERTIES OF GASES.

IN opening, at the Royal Institution, on Saturday last, the fourth lecture of his course on the above subject, Sir J. J. Thomson, O.M., P.R.S., said that in his last lecture he had described a possible way in which thunderstorms might arise. His lecture had been so quickly succeeded by a very violent storm that it might almost be considered as an experimental illustration. Some photographs representing an artificial flash or spark and actual lightning flashes might be of interest. The photograph of the spark was represented in Fig. 1, whilst Fig. 2 represented a typical flash. The principal point to which he would draw attention was that the main discharge was accompanied by branches developed laterally from point to point. It would also be noted that the flash was very far from straight, though no doubt part of the crookedness apparent was due to foreshortening. In Fig. 3 a multiple flash was represented, the first flash being followed quite quickly by a number of others, some of which appeared to be analogous to a steady discharge much more like that obtained in a vacuum tube than to a spark.

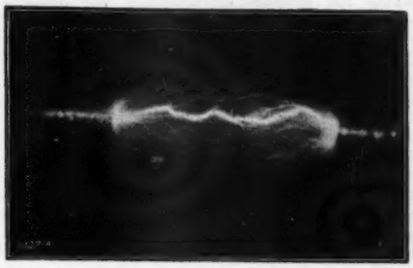


FIG. 1.

FIG. 2.

FIG. 3.

This, the lecturer continued, was to be expected, since the original flash ionised the gas, which retained its conductivity for a little time. If other flashes followed immediately after the first they would get through without having themselves to put the air into a conductive condition. He had suggested in his last lecture that globular lightning was the result of just such an ionisation of the air by a flash of the ordinary kind.

The subject of thunder had not, the speaker continued, been the subject of so much attention as had lightning. As shown in his last lecture, the passage of a spark through air was accompanied by a wave of high pressure, which could be detected by a jerk in the level of a water gauge connected up to a bulb through which the spark passed. A similar explosive wave was generated along the whole line of a lightning flash. It was usual to attribute the "roll" of thunder to the reflection of this wave from clouds, and this might, no doubt, play a large part in the phenomenon. It was, however, to be noted that Wilson had shown that the length of a flash was some six miles or so. It was evident, therefore, that to an observer favourably placed the sound would be drawn out for the time required by sound to travel over six miles. Hence, even without the aid of reflection, a peal of thunder might be considerably prolonged merely owing to the difference in the length of the path over which the sound had to travel to the observer. Moreover, in certain cases the flash might take such a direction that the part of the path nearest to an observer might lie somewhere about mid-length. In that case some points at the beginning and end of the flash would be equidistant, and the disturbances from them would reach an observer simultaneously, accentuating the sound into a crash.

It might be noted in this connection that our atmosphere had a natural periodicity of its own, and a flash six miles long might perhaps be capable of exciting vibrations of the atmosphere as a whole. It would be of interest to see if any kind of pressure wave could be detected after the passage of a flash.

Lightning conductors, Sir Joseph proceeded, might be regarded from two points of view, which should be kept more distinct than they frequently were. From one point of view a lightning conductor might be regarded as a decoy to draw fire and pass it safely to earth. It might also, however, be designed to prevent any discharge at all by reducing the intensity of the electric field in its neighbourhood. It then acted in an entirely different way. If used as a decoy it was very necessary to make sure that the path offered by the conductor constituted the shortest possible distance between the top of the conductor and the ground. With an impulsive current such as a flash of lightning the electrical resistance of a conductor was not of moment, there being no material difference between a very good conductor and an inferior one. What was important was that the length should be as small as possible. If this was not attended to there was a risk that the conductor might do more harm than good. The chief obstacle to the passage of an impulsive current was not resistance but electric inertia. A long wire resembled in this respect a long water pipe, in which it was difficult to suddenly start the fluid into motion. This reluctance of an impulsive current to follow a long path the lecturer illustrated by short-circuiting a spark gap by about 4 ft. of wire. With a steady current the whole flow took place along the wire, whilst an impulsive current sparked across the gap.

Another way of using conductors, he continued, was to arrange them so as to prevent the electric force over the area protected ever attaining so great an intensity as to permit of a flash coming down. In this case the conductors were provided with point terminals which, when the electric force reached a certain intensity, gave off a stream of electricity which formed a negative cloud above the building protected and below the positively charged base of the thundercloud. This stream of ionised gas reduced the electric force in the neighbourhood, covering in effect the building below with a conductor which, as Faraday showed long ago, would be a perfect protector. In this connection the wind might prove of considerable importance by spreading and distributing the ionised layer over a large area. A conceivable way of protecting towns from damage by lightning would be to encircle them with apparatus capable of producing ions. This would, on the approach of a storm, be set in action on the windward side of the town, and being carried over the latter by the wind, would act as a shield. This idea had not been as yet much developed. It had the advantage that the conductor was not put up to be shot at, but its function was to prevent the electric force rising to a dangerous pitch. To illustrate this effect the lecturer fitted a point to one of

the electrodes of a large induction machine and showed that the point then produced a luminous brush, which was in essence the same as St. Elmo's fire, which in certain conditions streamed upwards from pointed conductors into the air. He had himself seen it, at Cambridge, extending for many feet above the conductors of King's College Chapel. In the presence of this brush it was much more difficult to get sparks to pass between the terminals of the machine, and those that did pass were of not nearly so great an intensity as they would have been with the point replaced by a ball.

Leaving the subject of lightning, he would, the speaker proceeded, next consider other forms of discharge through gases. In the first place he would show how the appearance changed as the pressure was altered. With the gas at atmospheric pressure we got the familiar spark, which was the laboratory equivalent of lightning. On reducing the pressure, a peculiar bluish appearance was first seen over the surface of the glass, and as the exhaustion proceeded the character of the discharge became more and more diffuse, and later on a dark space appeared in the neighbourhood of the cathode and portions of the glass began to show a green phosphorescence, whilst the dark space grew larger and larger. Ultimately the discharge further differentiated. A fine velvety glow spread over the cathode, followed by a narrow dark space, known, the speaker said, as Crookes's dark space; following this came a short luminous portion known as the negative glow, and then a dark space of very varying length known as the Faraday dark space, whilst the remainder of the tube was filled with the so-called positive column of luminosity extending right up to the anode. In another experiment, in which the cathode was perforated, the lecturer showed that a stream of particles, the so-called positive rays, passed through this hole and produced luminosity behind. This was quite different in colour from the positive column and was not appreciably affected by a magnet, whilst, as the lecturer showed, the cathode rays were very readily deflected. There was thus a great difference between the positive rays and the cathode rays.

It was natural, he continued, to assume that the potential difference required to produce a discharge should be greater the greater the distance between the terminals and the greater the pressure of the intervening gas. Within limits both these conclusions were correct, but experiment showed that there were some highly interesting exceptions. It was, in fact, extraordinarily difficult to get very short sparks. With a constant gas pressure there was, in fact, a certain length between terminals with which the discharge would pass more easily than with any other length of gap, whether longer or shorter. Similarly with a constant distance between terminals there was some particular gas pressure at which the discharge passed most easily. If this pressure were either raised or lowered from this optimum value the discharge got through with greater difficulty.

To illustrate the first peculiarity the lecturer employed the discharge tube represented in Fig. 4. Here the two terminals are brought in as indicated, the space between their opposing ends being only

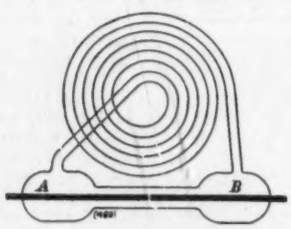


FIG. 4.

$\frac{1}{2}$ mm. An alternative path for the discharge was provided round the spiral tube shown, its length being about $\frac{1}{4}$ m. On coupling up the tube with an induction coil the lecturer showed that it was but rarely that a discharge passed across the $\frac{1}{2}$-mm. gap, but selected in general the path 100 times as long.

In short, the speaker proceeded, the potential required to produce a spark between two terminals depended on the quantity of gas which intervened. If this were constant, it mattered not whether the pressure were low and the distance great or the pressure high and the distance short, the potential needed was constant so long as the quantity of intervening gas was constant. Hence a very short spark might correspond to a very small quantity of gas, and a discharge would be facilitated either by raising the pressure or increasing the distance between the terminals.

To illustrate this the lecturer coupled up a discharge tube to an induction coil, and placed an ordinary spark gap in parallel with the discharge tube. At starting the pressure in the discharge tube was relatively high, and the whole of the discharge selected the spark gap for preference. The vacuum in the discharge tube was then improved by absorbing the gases in it by charcoal cooled with liquid air. As the exhaustion proceeded a point was reached at which the whole of the discharge passed through the tube and ceased across the spark gap, but on carrying the exhaustion still further the discharge in the tube ceased and the whole of the current passed again across the spark gap.

In a second experiment the barometric vacuum at the top of a long column of mercury was utilised as a discharge tube. A cathode floating on the mercury could be raised or lowered by raising the level of the mercury. The terminals of the discharge tube thus formed were coupled as before in parallel, with an alternative path for the spark. At starting the distance between the electrodes of the tube was great and all the discharge took the alternative path. With a certain length between electrodes, however, the discharge passed wholly through the tube and none across the alternative spark gap, but on still further raising the level of the mercury this gap came into action again and the discharge in the tube ceased.

In concluding his lecture the speaker exhibited a tube which had at one time belonged to De la Rue, and showed exceedingly well the striation often observed in the positive column of a discharge tube.

In this tube the positive column extended nearly from top to bottom and showed patches or layers alternately bright and dark, and nearly equally spaced throughout its whole length. Positive columns of this kind could, the speaker stated, be obtained of almost any length—in his own laboratory he had got them 50 ft. or 60 ft. long. The explanation of the striæ had, he said, been the subject of a good deal of discussion, with which he proposed to deal in his next lecture.

RADIOACTIVE HALOES.

THE interesting discourse on "Radioactive Haloes," which Professor John Joly, F.R.S., of Trinity College, Dublin, delivered at the Royal Institution on the 11th ult.—a lecture to which we referred in our article on "The Complexity of the Chemical Elements" published in our last issue—strikingly exemplified the extraordinary possibilities—and we might perhaps add temptations—of modern methods of research. That exact measurements of dark specks, only discernible in rocks under the microscope, should admit of speculations as to the evolution of the elements sounds surprising, even in our days of bold speculations. In introducing his lecture Professor Joly, who was, of course, dealing with problems of his own researches, said that minute discoloured patches, "pleochroic haloes," had been known in certain minerals since the microscope was applied to the study of rocks; as long as their nature was not understood at all they excited little interest, however. The most familiar type of halo consisted simply of a darkened border surrounding some minute mineral particle within the rock. When the particle was small, the halo might be equally developed in all directions; it then formed a sphere and in section a circular disc; that it was really a sphere was shown by taking cross-sections in different planes. Most of the photographs showed a beautiful regularity. Very few minerals could originate a halo, zircon and apatite being the most common, and that only in a few surrounding media, especially in certain brown varieties of mica; all these media, it was noteworthy, contained iron. The halo-producing minerals were all radioactive, emitting α, β, γ rays; only the α rays seemed to be concerned, the others being far too penetrating. When a halo was examined by polarised light the optical properties of the mica did not appear disturbed, but rather accentuated; thus the remarkable light absorption in the plane of cleavage was most complete in the halo. In one photograph exhibited the halo round a small crystal of zircon extended across the edges of two flakes of mica, inclined to one another; part of the disc appeared intense black, part grey. When the mineral was not embedded in a suitable medium, *e.g.*, in quartz free of iron, no halo would be produced there, but the halo would be visible in a speck of mica within the sphere of action. Such cases proved that the haloes were not "stains," produced by some gas or liquid diffusing out from the mineral.

The primary evidence for the radioactive origin of the haloes was found in their dimensions. Fully developed haloes occurred in two sizes, of radii 0.0333 mm. and 0.0408 mm. Now there were two chief radioactive elements, uranium, U, and thorium, Th. The former passed through eight stages in its decay during the liberation of α rays: U_1, U_2, ionium, radium, emanation, RaA, RaC, RaF; there were seven similar stages with thorium. Each product gave α rays of its own speed and ionising power, and the penetrating powers of the α rays from U ranged from 2.5 cm. up to 6.94 cm. (RaC) in air; with thorium the maximum penetrating power was 8.60 cm. (ThC). Calculating these penetrating powers for mica, Bragg found the maxima 0.0333 cm. and 0.0408 cm. for U and Th, the observed radii of the haloes. Most haloes were, however, not merely dark circular patches resembling over-developed photographs, but showed distinct rings limiting zones of more or less deep grey. How were these complex structures to be explained? Showing Geiger's ionisation diagrams, Professor Joly pointed out that as the ray travelled its ionising power rose first more or less steeply and then fell off rapidly; all the α rays from U gave similar curves, resembling the first half of the written letter *n*, differing only in the steepness of the up stroke. The summation curve obtained by integrating the α curves indicated the ranges of strong ionisation; it rapidly rose to a peak and descended to a minimum, again rising to a secondary maximum, and then dropped off to zero; there were several humps on the down branch. Now the abscissæ of the peak and the humps corresponded to the radii of the rings visible in the haloes. To understand the halo, another curve had, however, to be considered. Each particle travelled in a radius from the centre, and the different particles and radii diverged, of course; thus the haloes should weaken outward, owing to the spreading of the rays. This intensity curve rapidly fell off almost to zero, which it slowly approached finally; a halo, then, should consist of a dark disc surrounded by a penumbra. Such haloes with a narrow penumbra Professor Joly had indeed observed in granites of County Carlow; but the appearance depended upon the exposure, so to say, and in many haloes more detail was distinguishable.

With the aid of a series of what may be called progress-drawings—the photographs are not suitable for measurement—Professor Joly explained the structure. First only one ring or shell was seen outside the small nucleus; that first ring, which was not easy to photograph, plainly corresponded to the first maximum peak on the ionisation curve, due to rays from U_1 and also U_2. This first ring was frequently found, in succeeding stages of development, together with the earliest impression of the extreme ring (finally the fifth), due to the secondary maximum marking the extreme penetration range of the RaC rays. Ring 2 (next to 1) corresponded to the first hump on the down branch of the ionisation curve; it was generally weak, and by the time it appeared the inner nucleus had spread and blackened up considerably; a third ring then appeared. In the further development the detail inside the third ring was obliterated by the accumulating ionisation, the centre turning into a dark pupil. A very beautiful photograph exhibited showed the ring systems of two partly-overlapping haloes. The County Carlow granite haloes seemed to be due to emanation; in that case the α rays

from U_1,U_2 ionium, and radium would be absent, and the initiating (first) ring indeed appeared at a larger distance from the nucleus; but the final radius, due to RaC, was the same. Other photographs demonstrated that there was really good reason to believe that radium emanation had originated the halo. The mica of these photographs showed minute channels or cracks; some of these were dark, like Rutherford's capillary glass tubes containing emanation; the emanation seemed to have passed along these cracks or conduits, and produced dark haloes at spots where it met suitable particles of the medium (mica); on other photographs small dark discs seemed to have grown on delicate stalks.

Passing to thorium, the lecturer pointed out that the summation-curve of thorium showed two maxima close to one another, resembling in other respects the U curve, and that in the development of the Th halo two rings close to one another first made their appearance; the final six rings and their dimensions were in agreement with the curve. Thus there was very strong support for the assumption of the radioactive origin. But how was it that the spreading of the halo had not destroyed all the detail? There seemed to be some cause tending to accentuate the effects going on in the outer regions and weakening the inner effects. The formation of a halo by α rays was probably similar to the photographic action of light. Reversal or solarisation would lead to a weakening of the inner parts of the image, where the stimulus by the α rays would be more frequently repeated; α rays themselves affected the photographic plate like light; iron salts were very sensitive to light; it was also noteworthy that the haloes were unstable and disappeared when heated; the lecturer did not draw further attention to this latter point. The appearance of many haloes in which the outer portion was darker than the pupil further favoured this suggestion of reversal and of a photographic simile generally.

So far Professor Joly had dwelt upon agreement between observation and theory. Turning to his difficulties, he pointed out that the radius of the first Th ring was a little too small. That might be ascribed to the difficulty of the measurements; but our knowledge of the range of the α particles from Th itself was incomplete. Perhaps that range was larger than accepted. According to Rutherford there was a connection between the range of an α particle and the duration of life of the element from which it originated; the shorter the period of transformation, the greater the speed of the α ray. Plotting the logarithms of range and of period, Geiger and Nuttall had found that the rays from all the U and from all the Th products fell on two straight lines, but Th itself was a little off the line of the Th group. That might account for the slight discrepancy observed in the halo dimensions. There was a similar discrepancy as to the first U ring. In that case there was no doubt as to the exact range of the rays. But this discrepancy was only observed in very old granites, Devonian, certainly not younger than carboniferous, and the question suggested itself: had the range of U rays been longer in ancient times than it was now? That would imply that the decay had been more rapid in olden ages.

This question brought the lecturer to a consideration of recent speculations on the age of the earth From the rate of denudation of the earth's surface geologists allowed the earth 100,000,000, possibly 150,000,000 years. Astronomical estimates and the lunar theory did not afford much help; Kelvin's thermal estimate had been invalidated by Strutt's discovery of radioactive, heat-producing elements all over the earth's crust. Rutherford had suggested estimates based upon the accumulation of the products of radioactive decay. In the case of uranium those products were helium and lead. Lead seemed more suitable for such considerations, and the conclusion drawn from the accumulation of lead in uranium-bearing minerals was an age of 1,500,000,000 years; *i.e.*, 15 times the figure of geologists. That discrepancy was too great; it was inadmissible to assume that the rate of denudation was now 15 times greater than formerly. But an isotope of lead also seemed to be the final product of thorium, and from his study of lead in thorite from Ceylon, Soddy* calculated an age of 140,000,000 years. That agreement with the geological figure was hardly a mere coincidence. It had been objected that thorium lead might further turn into bismuth or an isotope of it (by losing an electron), or into an element of the thallium group (by losing an α ray); but Bi was not radioactive, none was found in thorite, and the haloes did not suggest any such changes.

To account for the great discrepancy between the estimates based upon U and upon Th there remained the possibilities that either U had in remote ages had a larger range and its decay had been faster, or that short-lived isotopes had existed and died out during geological times. These views were certainly not free from difficulties. In one respect, however, the halo evidence was not uncertain. There might formerly have been many radioactive elements whose activity had become extinct in comparatively recent times. The halo evidence disproved that assumption. The brown mica was one of the most widely diffused minerals; it integrated the effects of α rays, as a photographic plate integrated the effect of light. But a mineral containing a trace of radioactive element beamed like a star throughout ages, and the haloes allowed us to identify almost inconceivably minute traces of radioactive materials. Wherever, then, mica had remained unaffected, there was evidence of absence of radioactivity, and as all the haloes belonged to the U or to the Th types, there could not have been any general elemental evolution during geological time. When geological time began the earlier evolutionary processes must already have come to an end, with the exception of the known radioactive families.

* See ENGINEERING, page 502 *ante*.

SIX MONTHS' RAILWAY ACCIDENTS.

THE Board of Trade report on the railway accidents which occurred during the second half of 1916 has recently been published. The record constitutes a striking testimony to the vigilance and intelligence of our railwaymen. Never in all the prior history of our railways has the density of traffic attained such dimensions as during the period reviewed, and this traffic has had to be conducted with an enormously depleted staff, and with rolling-stock both deficient in quantity and, according to our old standards, inadequately maintained. Nevertheless, though serious accidents have not been avoided, the number compares favourably with the lists for 1912 and 1913.

Eight accidents, in one of which there was no injury to life, are dealt with in the report, which covers, as stated, a period of six months. In 1912 there were 16 collisions and seven derailments, causing either loss of life or serious personal injury, whilst in 1913, the last year before the war, there were 25 collisions and two derailments. Cromwell is reported to have expressed a preference for men who showed conscience in what they did, and the work of our railwaymen since the beginning of the war has, we believe, been characterised by a somewhat greater infusion of that desirable addition than was altogether usual in the years immediately preceding, a period during which there was much unrest in the railway world. This opinion is in no way affected by the deplorable accident at Gretna Green in 1915, where the loss of life far exceeded anything reported in British railway annals since 1853. In this accident 227 lives were lost, mostly those of soldiers, the highest death roll in any accident previously reported being the 80 of the Armagh accident in 1889. In this case the victims were mainly children.

The death roll in any accident is, of course, largely a matter of chance, the same kind of error may in the one case wreck a crowded troop train, as at Gretna, or merely a couple of goods trains carrying only the engine and van crews. The part played by chance in this respect is strikingly exemplified by the fact that the most serious of all the accidents dealt with in the report now under review occurred at Kiltimagh, on the Great Southern and Western Railway (Ireland), between a ballast train and an empty wagon train. This resulted in five deaths and injury to seven other individuals. In no other case did the death roll exceed two, although there were 30 injuries (mostly slight) inflicted in a collision on the Glasgow and Paisley Railway at Wallneuk Junction.

Kiltimagh, on the Great Southern and Western Railway, is a passing place on a single track line, between Claremorris and Swinford, which is worked by the electric train staff block system. It was originally intended that the ballast train responsible for the collision should run through Kiltimagh on to Swinford, only reducing speed sufficiently to exchange the train staffs. It was, however, detained 20 minutes by stalling on a bank, and consequently the signals at Kiltimagh were set against it, and a special train of empties accepted from Swinford. The driver of the ballast train, expecting, no doubt, to find the line clear at Kiltimagh, ran through the station past his signals, colliding with the train of empties. Contributory causes to the accident were the presence of a certain amount of fog and the greasy condition of the rails.

This running past signals is the characteristic feature of most of the accidents described in this report, and it is, perhaps, not without significance that in some of the cases the train was running with two engines. Whatever rules a company may lay down, it is hardly in human nature for an driver not to rely, consciously or subconsciously, on the vigilance of his mate. It may be recalled that in the Titanic inquiry Sir Ernest Shackleton objected to having two men on "look-out" together, as he found that "one man paid more attention than two," a view which was confirmed by railway experience in the United States when certain misguided, though possibly well-meaning, amateur reformers persuaded certain States to insist on a third man being carried on the locomotive footplate. In fact the maxim that there is safety in numbers is wholly inapplicable to cases of this kind.

An instance is afforded by the accident at Wigan on December 20 last to a night express to Edinburgh from Euston; this collided with another passenger train which weather conditions had made it necessary to shunt into a different bay from that which it usually occupied. In the course of this operation it was run into by an express to Edinburgh, a guard and a postal sorter being killed and seven others injured. The signals were properly set to protect the train being shunted. There were two engines on the Edinburgh express, and the driver of the first engine declared that all the distant signals were off, and that he was only able to see the adverse home signal when within 10 yards of the box. Other evidence, however, showed conclusively that the signals were against the train, and that he ran past five adverse signals. The Board of Trade inspector notes that the signalman at Wigan No. 1 box disobeyed rules in not bringing the express to a standstill at his box before lowering his home signal. The driver appears to have assumed that as he was not stopped here he had a clear run through Wigan station, and accordingly took no particular care in looking out for the signals subsequently passed, all of which were against him.

A not dissimilar accident occurred on December 18 at Oakley Junction, on the Midland line from Bedford to Northampton. Here the night train from Carlisle, hauled by two engines, ran past its signals and collided with an empty troop train. Fortunately both passengers and crew escaped without injury. In this case a contributory cause of the accident lay in the fact that the signal-box at Oakley station is closed on Sundays and not reopened till 6 o'clock on Monday mornings. When the Carlisle express is on time it passes through Oakley on Mondays before the signal-box is opened there. The train was late, however, and possibly the force of custom led the drivers to overlook the signals.

Still another accident in which the train responsible for the accident was hauled by two engines occurred at Kirtlebridge, on the Caledonian Railway, on December 22, 1916. In this case a special goods train from Carlisle to Carstairs was run into from behind by the 2.45 a.m. down postal train from Carlisle, which left about an hour late. A brakesman on the goods train was killed, and there were four cases of injury. Here, again, the Board of Trade

inspector concludes that the drivers, in spite of their assertions to the contrary, failed to observe the signals, which, he was convinced, were against them, since the signalman's evidence in this respect is unusually well confirmed. A peculiar and disquieting feature of the case is that it was proved that in addition to setting his signals against the train the signalman had placed detonators on the track, which exploded without attracting the attention of either driver. The night was stormy, with showers of snow, and the men were probably sheltering themselves in their cabs as much as possible.

Another accident for which failure to observe or obey signals was responsible occurred between two passenger trains at Warminster Junction, on the Great Western Railway. As a consequence a soldier was killed and there were 14 cases of injury. Here, again, the customary routine in the working of the line at this place was slightly varied. Owing to a difficulty in working a cross-over disc signal indicator, the signalman determined to pass a special Saturday train from Bath, which was on the down line, over on to the up line by another than the usual crossing. This operation was necessary so as to allow the down express from Bristol to pass. An up train to Bristol was due and, in spite of the signals against it, it ran on and collided with the waiting train. This occurred although the driver had received and acknowledged a verbal warning at Heytesbury signal-box that Warminster station was blocked. He was only roused by a warning whistle from the waiting train, too late to be of service. The evidence shows that after receiving the warning noted above he ran on with his hand on the regulator, but he states that he has no recollection of anything that happened after being stopped at Heytesbury station. One effect of the collision was to start a fire from the compressed gas used for lighting the carriages. These were old stock, used on the Metropolitan Railway before the electrification of the latter, which, ordinarily kept as a reserve for emergencies, had to be put into service owing to the present traffic requirements. Fortunately the fire was extinguished without such serious results as followed in the Aisgill disaster.

The foregoing instance lends weight to the inspector's plea for the devising of some satisfactory apparatus for shutting off steam automatically should a driver overrun his signals. Experiments to this end were in progress for some years before the war, and apparatus for applying the brakes automatically and giving an audible warning signal have been fitted at a number of distant signal posts on the Great Western line. The exigencies due to the war have prevented further progress. No system can, of course, be generally adopted until it has been thoroughly tested in service conditions over a prolonged period and in varied situations. In the meantime the suggestion is put forward that more use should be made of the mechanical fog signal placers worked directly from the signal cabin. On some lines these are kept charged all the year round, and if the overrunning of a home signal was always followed by the explosion of a detonator there would be additional security against lapses of attention on the part of the driver. In one of the cases dealt with above even this precaution proved ineffective.

A driver was also in fault in the collision on the Glasgow and Paisley joint line at Wallneuk Junction. In this case the driver of a goods train, which was on a loop line at the junction, mistook a signal lowered for a passenger train on the adjoining main line for his own, and went forward accordingly. His engine and some wagons were derailed at the catch points, and fouled the passenger train. Fortunately no one was killed, but 30 were injured. In this case the inspector reports that the arrangement of the signals is open to criticism, and the evidence showed that two previous instances were on record in which a misreading of the signals here had led to mishaps.

NOTES.

Internal Friction of Fluids and Slip.

In investigations of the flow of liquids through straight tubes it is assumed that there might be a slip between the walls of the tube and the liquid. Girard observed a slip in 1813 when water was flowing through copper tubes. Poiseuille found, in 1846, that the coefficient of slip was certainly zero for water in glass tubes, and his formula for the time of efflux of a given volume of water through a tube is directly as the length of the tube and inversely as the difference of the pressures at the ends of the tube and as the fourth power of the diameter. A slip coefficient does not enter into his formula, therefore, and that is accepted (among others) by Horace Lamb in his "Hydrodynamics," with a brief reference to the contrary experiments of Helmholtz and Piotrowski, of 1860. Using a different method, viz., observing the decrement in the time of swing of a sphere, polished and gilt inside, bifilarly suspended and filled with various liquids, Helmholtz observed a considerable slip which would become a factor in the flow of water through the tubes of small diameter. But the observation was questioned and not confirmed. Repeating the experiments with a silvered glass sphere and making very careful flow tests in glass tubes, D. Whetham (1890) considered the damping method unsuitable, and failed to observe any slip of more than half per cent. possibly. Ladenburg, Drew and others also doubted the existence of a slip in liquids; on the other hand, Kundt and Warburg observed a slip in gases when at reduced pressure. The most recent experiments of Győző Zemplén and Béla Pogány, conducted in the Physical Institute at Budapest, of which Eötvös is director, again fail to show any appreciable slip. Zemplén began his experiments on internal friction of gases (air and carbon dioxide) in 1909, and the *Annalen der Physik*, vol. xlix, pages 39 to 70, February, 1916, contains his third communication dealing with water. He uses two concentric spheres, of copper, the outer turned about its vertical axis at a uniform speed by an electric motor or clockwork, the inner suspended by a wire; between the two spheres is the fluid, and the torque on the inner sphere is measured. In the water experiments water also filled the box in which the system was mounted, while the inner sphere was partly filled with shot to balance the buoyancy. The radius of the outer sphere was 5.5645 cm., that of the inner 4.1757 cm.; a larger inner sphere was also used. The speed of the outer sphere was varied through a large range, the time of one revolution Ω being raised from 0.17 second to 9,300 seconds (2½ hours). The theory of the fluid motion between two concentric spheres had been given by Kirchhoff. For low speeds the torque exerted is proportional to the internal friction η, which is then independent of Ω; for higher speeds the torque becomes proportional to η^1, which is a function of Ω, η^1 being $\eta\ (1 + B_2 x^2 + B_4 x^4 \ldots)$ where $x^2 = \rho^2/\eta^2\ \Omega^2$, ρ being the density. Rayleigh and Lamb had restricted Kirchoff's formula to very low speeds; Zemplén finds that the formula practically holds over much larger ranges in the case of air and carbon dioxide and over a slightly extended range in the case of water. Plotting the ratio η^1/η against the x, he also finds that all the values for air, carbon dioxide and water fall on the same curve (almost a straight line), so that the constants B are independent of the substance, although water is nearly 800 times denser and 50 times more viscous than air. The chief other results are that no turbulence was observed in the fluid at speeds considerably exceeding the critical speed of Reynolds—the turbulent flow through tubes might be an end effect, Zemplén suggests—and that there was no indication of a slip in the experiments with copper spheres of two different diameters. These latter experiments can hardly be regarded as conclusive. His η of dried air was 1.9114×10^{-4} at 18 deg. C., (about 1 per cent. higher for moist air); the η for water was 1.0562×10^{-2} at 18 deg. C.; Poiseuille's figure was 1.076 at 17.5 deg., when Zemplén's would be 1.069.

Zirconia Crucibles.

The possibilities of zirconia as refractory material have been much urged of late, and experimenting with zirconia is going on in various quarters. The account of the recent continued work of Professor O. Ruff and his collaborators at Danzig (*Zeitschrift für Anorganische Chemie*, vol. xcvii, pages 73 to 112, September, 1916) is encouraging. The new crucibles made of zirconia, with small additions of other oxides, could bear temperatures of 2,200 and even 2,400 deg. C. But there are difficulties caused by the affinity of zirconia for carbon and by other factors, and the temperature at which the zirconia had been baked proved to be a factor of considerable influence. In their new researches Ruff and G. Lauschke had at their disposal a crude zirconia (83.5 per cent. of Zr_2O_3, 11.5 SiO_2, 4.6 Fe_2O_3) and a purified zirconia (98.75 Zr_2O_3, 0.95 SiO_2, 0.27 Fe_2O_3). Various samples of the latter had been baked at five temperatures, ranging from 750 to 1,400 deg. C., and these samples, ranging in density from 5.7 down to 4.99, were kept separate during the experiments. Small cylinders were in the first instance prepared by mixing the zirconia with water (9 or 10 per cent. answered best) and sometimes also with starch (1 per cent.). Melting-point determinations of the materials were made in the vacuum electric carbon-tube furnace of Ruff, at pressures from 5 mm. of mercury upward, sometimes in a hydrogen atmosphere. The following temperatures indicate visible melting of the cylinders:—Zirconia, 2,563 deg. C.—this point was the same for all the samples, also in hydrogen at low pressures, a high hydrogen pressure lowered the melting-point; silica, SiO_2, 1,850 (fused to a white bead); glucina (beryllium oxide BeO), 2,410 (no vapours; this point is lower than that previously found by Ruff*); magnesia could not be melted, it evaporated completely when heated above 2,000 to 2,690 deg.; Al_2O_3, 2,005 to 2,008 (very little vapour); thoria, ThO_2 gave white mists above 2,400, but was not melted at 2,780 (formerly melted at 2,425 or 2,470); yttria, Y_2O_3, 2,410 (vapours above 2,350) deg. The addition of any of these oxides to zirconia lowered the melting-point, but raised it in the case of ThO_2 and Y_2O_3. Crucibles were then pressed (between two dies) of zirconia, to which 1, 3, or 6 per cent. of the other oxides were added, the mixture containing also water and starch, as stated. The crucibles were straight cylinders, made in two sizes, 45 or 30 mm. high, 28 or 15 mm. external diameter, 3 or 1.5 mm. wall thickness. They were baked while standing in a Hessian crucible on crude zirconia, and then heated in the electric furnace for 70 minutes up to 2,400 deg. maximum. In strength the soft and baked zirconia crucibles resembled clay. It resulted that some carbide formation (from the carbon vapours) was unavoidable. To reduce it the crucibles were placed within covered crucibles of crude zirconia, which suffered in their turn; some oxides, volatilised from the outer crucible, then condensed on the inner. During this baking in the electric furnace the crucibles altered their shape slightly; they became coloured (yellow, green, reddish, blue, grey, &c., sometimes mottled), turned crystalline, increased their strength (especially if previously baked at low temperature), and altered their weight, losing up to 20 per cent. (moisture, chemical reduction, volatilisation), and, on the other hand, gaining in weight by the just-mentioned condensation. There was also shrinkage, and the porosity increased, owing to the volatilisation, especially of the added oxides; the porosity was determined by evacuating the pores and then letting water soak into them; the deduced porosities, 4 to 39 per cent., were probably too high. This treatment was followed by heating the crucibles in the oxidising blowpipe flame, when the gay colours turned into yellow-red (iron oxide). Many of the crucibles crumbled in this flame, because the carbides and lower oxides formed in the reducing atmosphere of the carbon furnace were reoxidised; those baked at 2,000 deg. stood the oxidation better than those baked at 2,400, and the crucibles containing 6 per cent. of alumina proved strongest. The surviving crucibles were finally heated to the highest temperatures in the electric furnace and then analysed; the analyses proved difficult, particularly the separation of the zirconia from the yttria or some unknown constituent by hydrofluoric acid. The conclusion is that the addition of oxides to be made should depend upon the temperature at which the zirconia is to be baked: if at 2,000 deg., add 1 per cent. of alumina; if at 2,200, 1 per cent. of thoria; if at 2,400, 1 to 3 per cent. of yttria. Higher percentages would only increase the porosity; glucina, magnesia and silica are not to be recommended.

* ENGINEERING, July 23, 1915, page 90.

INDUSTRIAL NOTES.

THE office of Sir George Askwith, Chief Industrial Commissioner, has been transferred from Old Palace-yard, and the new address will be Ministry of Labour, Montagu House, Whitehall, London, S.W. 1.

The Shipping Controller announces that, by an arrangement with the Mersey Docks and Harbour Board, he has appointed Mr. L. A. P. Warner, deputy general manager under the Board, to take charge of the Department of the Ministry of Shipping responsible for port work and the development of the ports. The question of facilities at the southern and western ports is among the matters to which special attention is being given. Mr. Warner will work in close touch with the Royal Commission on Wheat Supplies, the Railway Executive and other bodies concerned. The Ministry has also secured the services of Mr. A. H. Read, Liverpool, who will be specially concerned with questions affecting the coastal trade of the United Kingdom.

The Building Trades Central Advisory Committee (Operatives), which advises and assists the Ministry of Labour upon matters affecting workmen in connection with Employment Exchanges has held its third meeting. The committee received a statement with regard to the steps being taken by the Department to assist associations to comply with the recommendations of the Treasury Committee on the audit of claims for repayment under Section 106 of the National Insurance Act, 1911, in respect of unemployment benefit paid by the associations. The committee also considered: (*a*) The best means of avoiding delay in the placing of men sent by Employment Exchanges from one town or district to another. (*b*) The desirability, when appointing Employment Exchange officials, whose duty it will be to deal with applicants for employment, of giving due consideration to their qualifications both as regards knowledge of industrial conditions, and ability to deal sympathetically with workmen.

It was reported to the committee that the Ministry of Munitions had decided to extend the list of occupations for which men are eligible for enrolment as War Munition Volunteers to include bricklayers and general labourers suitable for munitions or shipyard work.

An agreement was made on May 23 between the British Flint Glass Manufacturers' Association and the United Flint Glass Cutters' Society, at a meeting held under the chairmanship of Sir George Askwith, with regard to the employment of women and the wages of the men. Wages of women are to be settled at a joint meeting, and, failing agreement, to be referred to conciliation or arbitration. In view of the present national position, the men withdrew all objections to the employment of women for the period of the war, and among other terms it was arranged that the parties should meet from time to time to consider the position of the trade, exchange views and, where possible, settle difficulties that may arise; not more than three months are to intervene between each meeting. Rates of wages were increased from the first pay-day in May by 5*s.* per man in the Stourbridge district and 3*s.* per man in the Manchester, Warrington and Birmingham districts; the higher rates in the Stourbridge district being given with the object of equalising glass cutters' rates. All notices to cease work are also withdrawn.

By request of both parties, Sir George Askwith presided as chairman over a meeting of the London Master Printers' Association and the London Society of Compositors. The result was that the representatives agreed to lay before their societies a proposal to settle claims by a further war bonus of 4*s.* weekly on and after the first pay-day in June. This proposal has now been accepted by both sides. It has been further agreed that a conference be held with a view to dealing with the shortage of labour and to meeting the pending release of men of military age.

The engineering strike is now over and matters have become normal in the various establishments in which difficulties had occurred. Dealing with the subject in the House of Commons last Friday, the Prime Minister stated that the termination of the strike afforded a very good opportunity for reviewing the whole of the labour position. He trusted that, as far as the particular dispute which occasioned the recent strike was concerned, it had been happily terminated; but he agreed that there was a good deal of matter for further investigation. There had been great unrest in some quarters. The Government had their views as to how that had been fostered, but at the same time there were some genuine grievances, which had assisted the designs of those who had ulterior motives having no special reference to the labour situation, and therefore the Government had decided to appoint a Commission of Inquiry into the industrial unrest, to inquire and report upon the operation of all the war emergency legislation of the Government and its administration in regard to labour, and to make recommendations which would tend to minimise industrial unrest, especially in the shipbuilding and engineering trades, during the continuation of the war. It was proposed to divide the country into something like seven areas, and to appoint separate Commissions to investigate the causes of unrest in each of those areas. An effort would be made to secure the services of a Labour representative and of an employer, with an impartial chairman in each case. Inasmuch as it would be impossible for any Commission to cover the whole ground in anything like reasonable time, it had been decided to divide the country into seven areas and to investigate the industrial unrest in each of those areas with a view to advising the Government whether it was desirable either to make alterations from the administrative point of view or to recommend legislative changes.

The representatives of all sections of the weaving branch of the cotton trade who, as stated on page 507 *ante*, met at Blackburn last Saturday, agreed to accept the offer made by the employers of a 10 per cent. advance in wages, as from the first pay-day in July next.

The Association of Engineering and Shipbuilding Draughtsmen, 94, Hope-street, Glasgow, have issued a memorandum asking that the Munitions of War Act be amended, so as to remove the disabilities under which draughtsmen are now suffering. The high technical skill and training demanded of qualified draughtsmen can only be acquired by taking advantage of such experience as is to be gained by serving with various firms, and the confinement of younger draughtsmen to their present employment is reflecting seriously on their qualifications. Owing to the difficulties imposed on draughtsmen in obtaining leaving certificates to enable them to secure a change of employment, posts demanding a high degree of technical skill have been filled by men whose training has been inadequate, but who have been enabled—often owing to their lack of technical ability—to obtain their clearance certificates from their former employers. The memorandum further discusses the situation, and concludes by stating that while the loyal support of draughtsmen is assured in their desire to co-operate with the Government in all measures which may be considered essential to the industrial requirements, the general desire to amend the Munitions Act and so provide greater freedom of movement springs from the knowledge that such amendment would enable the nation to obtain a fuller value from the technical skill possessed by draughtsmen, and the association have been urged by the majority of draughtsmen in the United Kingdom to bring their request before Members of Parliament with a view to obtaining their interest and so secure the necessary mobility essential to maintaining the status of the profession.

An exhibition of women's work was opened on Wednesday, May 30, at the Royal Colonial Institute, Bristol, by the Lord Mayor of that city. The exhibition is one of a series which have been arranged for various industrial centres by the Labour Supply Department of the Ministry of Munitions, in order to demonstrate the highly important part which women are now taking in the production of munitions of war. The work which women have proved themselves capable of doing successfully, both from the technical and economic standpoints, is wonderful in its variety, and now comprises processes which require a very high degree of skill.

We read in *The Iron Age*, New York, that following the decision of the American Railway Master Mechanics' Association and the Master Car Builders' Association, on April 30, to forego the Atlantic City conventions this year, and a like stand taken by the electric railroad interests, which have met annually in October at Atlantic City, the fourteenth annual convention of the Railway Storekeepers' Association, which was scheduled to take place on May 21 to 23, at Chicago, has been indefinitely postponed. Mr. W. A. Summerhays, Illinois Central Railroad, president of the Association in his letter of announcement says:—

"We are passing through a time of national peril, and our President has called on each individual to do his allotted task with good will and to the best of his ability. On no one line of endeavour does the nation depend at this time more than on the transportation companies, and it is hard to realise how any individual will have better opportunity to perform service for his country than falls to the lot of the railroad men. In considering the work to be done by associations of railroad officers in getting together at conventions to compare notes and discuss methods, the first thought is usually that under these extraordinary conditions even more good can be accomplished than ordinarily. On second thought, however, it is readily to be seen that the place for each railroad employee is at home, attending strictly to his individual duties, and there is no time for him to be absent, even for a few days, to attend a convention."

According to *The Railway Mechanical Engineer*, New York, the Council of National Defence has adopted a report of its Labour Committee, of which Samuel Gompers, president of the American Federation of Labour, is chairman, recommending that the Council shall issue a statement to employers and employees in industrial plants and transportation systems, advising that neither employers nor employees shall endeavour to take advantage of the country's necessities to change existing standards of wages and working conditions. It is recommended that when economic or other emergencies arise requiring changes of standards, the same shall be made only after such proposed changes have been investigated and approved by the Council of National Defence. It is further recommended that the Council urge upon the legislatures of the States that before final adjournment they delegate to the governors of the respective States power to suspend or modify restrictions contained in their labour laws when requested by the Council of National Defence for a specified period, not to exceed the duration of the war.

ELECTRIC ARCS IN ETHER.—In a contribution to No. 4 of the "Archive for Mathematics, Astronomy and Physics," of Stockholm, 1916, A. Rönnholm describes some interesting experiments on the behaviour of arcs produced in ether between metal electrodes, in parallel to capacity-reactance circuits. It was found that for each resistance there was a certain current range, over which oscillations were produced and the arc could not be maintained. The peculiarities are best explained by reference to a diagram. Plotting the volts across the arc as ordinates against the currents, and drawing diverging lines from a point marking the line potential (220 volts) to different points on the abscissa (0.4 amperes to 2 amperes), we get a kind of fan of divergent outlines, and a belt crossing this fan, not of uniform breadth, but of fairly regular outline, would mark the range within which the current oscillated. This belt becomes wider with increasing capacity and narrower with increasing inductance; the greater the conductivity of the electrodes, the wider the region of oscillations, which was wide for copper and narrower for aluminium and still narrower for iron. Thermal relations evidently have a good deal to do with the phenomena; when the two electrodes were not of the same metal, the anode, getting hotter, was of greater importance than the kathode. The frequency of the oscillations did not appear to depend on the nature of the metal.

RAILWAY EXPANSION IN THE MALAY PENINSULA.—Notwithstanding the turmoil in Europe, the British authorities in the Malay Peninsula have been steadily pursuing a progressive policy of railway extension which has been retarded only by the difficulty of obtaining supplies of ironwork from the United Kingdom. Under the Treaty of 1909, which transferred the Malay States of Kedah, Perlis, Kelantan and Trengganu from Siamese to British suzerainty, the Federated Malay States authorities agreed to lend a sum of 4,000,000*l.* (afterwards increased to 4,750,000*l.*) to the Siamese Government to enable Siam to extend the State Railway southwards to form connections with the Federated Malay States Railway at the frontiers of Kelantan on the east and of Perlis on the west. The work has made steady progress, and is rapidly nearing completion. On their part, the Federated Malay States Railway authorities have been pushing on the extensions northward, through the western States of Kedah and Perlis; and recently Mr. P. A. Anthony, the general manager of the Federated Malay States Railways, accompanied by some members of his staff and Mr. H. Gittins, the chief engineer of the Siamese State Railway, made the journey by train from Bangkok to Prai on the mainland, opposite to the island of Penang, by way of Bukit Mertajam, the junction in Province Wellesley. The party was thus the first to make the journey over the new railway connecting Singapore and Penang with the capital of Siam. The line on either side of the frontier cannot be considered complete, and may not be opened to general traffic till next year. A number of bridges and other masonry work remain to be completed on the Siamese side, and the final work will be taken in hand as soon as possible. On the British side only the ironwork of a few bridges awaits completion. Portions of the line have been finished in Northern Kelantan, while an extension of the existing Federated Malay States Railway system has been made from the junction at Gemas, through the eastern State of Penang northwards as far as Kuala Lipis, with a view of linking up with the Kelantan section as soon as opportunity offers. The value of these railway extensions will be obvious to any one who takes the trouble to look at the map of the Malay Peninsula. The railway will open up rich tracts of land for mining exploitation and tropical cultivation in a region which has already proved a valuable asset to the British Empire. Its commercial convenience will also be great, while transit for mails and passengers from Europe to Bangkok will be shortened by several days, and the sea journey up the Gulf of Siam—a nasty one in the north-east monsoon—will be avoided.

"THE ELECTRICAL PROPERTIES OF GASES."

To the Editor of Engineering.

Sir,—The dissertation of "Didymus" on the meaning of the word "know" should have been addressed to Sir J. J. Thomson, not to me, because I merely quoted what he was reported to have said, viz.: "We now *know* that electricity was, so to speak, atomic in structure." All attempts to weigh heat have failed. Has any one succeeded in weighing electricity? If atomic, it is surely ponderable!

Not being more of a "crank" than the majority of engineers, I was careful to ask "how can it be demonstrated that each chemical atom is *a little universe comprising many planets and suns*?" and the reply of "Didymus" reminds me of the danger alluded to by "Old Millwright," in Engineering of August 30, 1912, "the moment he is led into meta-mechanics, a student develops a condition of mind favourable for the reception of ideas characteristic of psychical researchers"—the unsoundness of whose conclusions is scarcely distinguishable from insanity.

An Earnest Student.

London, May 26, 1917.

To the Editor of Engineering.

Sir,—It is refreshing to hear such voices as those of "Earnest Student," "Didymus" and "Sesamy" raised in a circle of those who deal with hard iron. Would that every scientist were as metaphysical as "Didymus" and as sceptical as "Earnest Student"! But let "Didymus" beware of *his* meaning of "knowledge," for it is not the current interpretation! The man who, resting on his power of analysis, says "I know," is scarcely as modest and truthful as he who says "I opine." Words partly depend for their meaning upon the theme, speaker, hearer and circumstances under which they are spoken.

A "working theory" is an excellent thing—for the practical engineer: for the philosopher it is useless. Up to a certain limit it is *useful* to think of electricity as a fluid and "lines of force" as elastic strings. The philosopher ("Didymus" will appreciate this) regarding things strictly "anthropocentrically" (*i.e.*, from the human point of view) should challenge the absolute existence of matter and electricity as much as of lines of force. "Didymus" sits in his little observatory and receives physical impressions of five varieties through five different organs. Consciously and subconsciously he arranges these impressions into a vast number of permutations and combinations, which he calls "wood," "water," "air," &c. After studying certain phenomena he finds it a convenient aid to thought to classify phenomena as "electrical," "chemical," &c., and (as a working theory) to assume the existence of what he calls "electricity," "energy," "momentum," &c. If he is (as I hope "Didymus" is, for engineers' sake) an engineer who regards this all as engineering, so well and good: but if he is a prominent physicist to whom the unscientific and unphilosophical crowd look for a pronouncement on natural philosophy, an "I venture to think" may be safe, but an "I know" is demoralising.

Yours apologetically,

May 26, 1917. Credoindeo.

To the Editor of Engineering.

Sir,—I have to thank you for sending to me a proof of the further letter from "Earnest Student," as it saves time, and precludes the possibility of any shadow of success attending his repetition of an old controversial trick, viz., "when cornered alter your ground." As he knows perfectly well, he did not in his first letter "merely quote Sir J. J. Thomson." He asked a definite question, viz., How certain things were demonstrated? In reply I told him that they were known in the same way and in the same sense as we know that Newton's laws apply to the solar system. Being unable to give a reasoned reply to this he now introduces new topics by rambling references to the weight of heat, &c. He is, moreover, totally wrong in asserting that my dissertation on the meaning of the word "knowledge" should have been addressed to Sir J. J. Thomson, who long ago defined a scientific theory "as a policy, not a creed." I was therefore already possessed of the meaning that eminent physicist attached to the word "know," but what I did lack was a definition of the word by "Earnest Student," and I may observe that I have not got this yet, an evasion which does more credit to your correspondent's discretion than to his sincerity as an honest controversalist.

If "Earnest Student" were competent to discuss the theme on which he has so rashly ventured, he would know that the mass of the electron has been measured by methods in every way analogous to those by which the masses of the various components of the solar system have been determined. This answers his question as to whether anyone has succeeded in "weighing" electricity, though the sense in which he uses the word weight requires definition. Weight, as he probably does not know, is an accidental concomitant of matter varying with its position in the universe.

In any case his fundamental assumption that a quantitative unit must necessarily have weight is fundamentally wrong, it being just as sensible and as practical to determine the weight of a unit of length as that of a British thermal unit. Both are, nevertheless, as serviceable counters to use in co-ordinating our thoughts on the external world (of which it is convenient to assume the existence) as is the pound avoirdupois or the kilogram. These topics were, however, only introduced by your correspondent to evade the issue originally raised by himself, and till he has dealt in a reasoned argument with this I refuse to discuss these new issues further.

In conclusion I note that "Earnest Student" refers appreciatively to an article by "An Old Millwright," which was remarkable mainly for the writer's ignorance of scientific method and scientific history. Also in your last issue "Sesamy" expresses his agreement with "Earnest Student." I should be glad to have an assurance that this mutual admiration trio is not really a living illustration of the mystery of the Trinity and that all three are not one and the same individual. Such a state of affairs would be in thorough keeping with the attempt to distract attention from his inability to give a reasoned reply to my letter.

Yours truly,

Croydon, May 29, 1917. Didymus.

PATENTEES AND THE PROLONGATION OF PATENTS.

To the Editor of Engineering.

Sir,—Since the publication of your article on the above matter, and my letter of appreciation, I hear a good deal from one quarter and another of the need for a movement being started amongst patentees to demand some measure of consideration from the Government in regard to the losses incurred by patentees through their businesses being suspended in favour of conducting the businesses of the war.

Enclosed herewith is a copy of a letter which I received from Mr. C. H. Beadle, managing director of Power Progress, Limited, Southampton, which I think very clearly expresses some of the views held by patentees, and also indicates the nature of the welcome that would be extended to the initiation of any movement for this purpose. I should suggest such a movement could be most effectively made under the leadership of such a journal as yours—having connections with and acting as guardian of the interests of all classes of engineering business, and a reputation of considerable weight in the world.

Engineering industries are interested directly in mechanical inventions, which constitute the bulk of patents. Accordingly, the engineering industry is that most vitally interested in a movement for obtaining prolongation of patents, and the different branches of engineering, uniting under some general leadership, would have the best prospect of obtaining the supplementation of the patent law which is so vitally needed.

I shall be glad to hear that you can carry the matter through, and if I can be of any service to you in doing this, please command me.

Yours truly,

Arthur E. Jerram.

"Inglenook," Oadby, Leicester, May 23, 1917.

Copy of letter received from Power Progress, Limited, Cray Laboratory, Sugar House Lane, Southampton.

Arthur E. Jerram, Esq., May 21, 1917.
"Inglenook," Oadby, Leicester.

Prolongation of Patent.

Dear Sir,—We are in perfect agreement with your letter of 15th inst. in Engineering, as the time has certainly gone when ingenuity can suggest a multitude of small improvements and turn them into useful estate under patents covering short periods. Invention is now very generally exercised upon new methods and processes involving practically a lifetime of self-education, experimenting and specialised ingenuity, as well as great monetary outlay, towards all of which the present term of a patent is totally inadequate. The war turns this condition into absolute disaster, and we certainly feel strongly the need of some sort of bond among patentees to insist upon the steps you advocate being taken. Our business is quite a small concern, but seriously engaged in a very long line of research, and we would like to do our little share. If, therefore, you see your way to initiate the movement you propose we should esteem it an honour to be counted upon for a subscription of ten guineas towards its formation.

Very cordially thanking you for your suggested active interest,

We are, dear sir, yours faithfully,
Power Progress, Limited,
(Signed) Chas. Hyde Beadle,
Managing Director.

To the Editor of Engineering.

Sir,—I read with much interest your article in the issue of Engineering dated May 11, with reference to "Patentees and the Prolongation of Patents." The loss inflicted not only upon patentees but also on their licensees is so obvious that one feels sure that there will be the desire on the part of the authorities to compensate them in some way for the injury suffered by them.

As a concrete instance there is the case of a small company with which I am connected that clearly illustrates the damage sustained. This company makes a patented appliance for windows in large buildings, which was only just making its mark and coming into general use after a considerable expenditure of money and energy in developing it. The company did not make the article, but had it manufactured for them. Soon after the outbreak of war the Government prohibited all building operations, and consequently the company's home business ceased, even had they been able to get the articles manufactured. But the restriction on steel and copper, and the occupation of the makers on munitions, brought the company's export work also to a standstill. Apart from the patent question, the company's business was stopped through the war. The patent expires in December next, and all renewal fees have been paid.

This is only one case among many of such obvious hardship that it cannot be doubted that the authorities will give it consideration. The only question is, how the remedy will be applied. Your suggestion seems an excellent one. The patentee should not be further penalised by expensive and slow legal formalities, but the matter settled by the Patent Office, acting on the advice of a body such as you suggest.

Yours faithfully,

J. W. Nasmith.

Griffin Works, Richard-street, Stockport,
May 23, 1917.

DRAUGHTSMEN AND FOREMEN.

To the Editor of Engineering.

Sir,—In your issue of May 25 a correspondent, in a letter under the heading "Draughtsmen and Foremen," acquiesces in the idea that a draughtsman's work is unproductive, and thereby perpetuates a fallacy which is to some extent responsible for the present condition of draughtsmen. This earns for them the reproach of being a necessary evil.

Now, as a matter of fact, a draughtsman's work is essentially productive. He has in many cases to scheme out the type of machine he has in hand, to give directions regarding fitting limits and material, and to order the parts. This is obviously as productive as the work of the mechanic who handles and makes the parts. It is more truly production than any other part of the office work.

There has recently grown up a practice of comparing the present status of draughtsmen with that of doctors and lawyers. Now, so far as the writer is aware, there is no examination to become a member of the Draughtsmen's Association, while for membership of the above professions extensive training and examination are necessary. It would perhaps be better to compare draughtsmen with their colleagues (if I may use the term) in the shops, who have no examination for their trade union, and who, as apprentices, attend evening classes.

There are draughtsmen and draughtsmen, and if instead of so much windy rhetoric some thought was devoted to raising the standard by examination and by some scheme of Government registration, the status of draughtsmen would be raised.

Yours sincerely,

Harold C. Clausen.

5, Leighton Buildings, Westminster, London, S.W. 1,
May 29, 1917.

THE METRIC SYSTEM.

To the Editor of Engineering.

Sir,—I am always much interested in the question of the metric system.

Is there any reason why metric names should not be given to the numerous English and American standard screw threads, pipe fittings, &c.? A 2-in. pipe, for instance, is not usually exactly 2 in. It could be reproduced exactly as easily if it were called a 5-cm. pipe. A 1-in. screw could be called a 25-mm. screw, and so on. The Whitworth threads named in metric units would be just as satisfactory as when they are named in English units; thus we might have a 25-mm. Whitworth screw and a 25-mm. international screw and a 25-mm. automobile screw, &c.

The use of metric names would answer a great many of the unsound arguments made by opposers to the metric system.

Very truly yours,

R. S. Hale.

939, Boylston-street, Boston, U.S.A., May 10, 1917.

LABOUR ECONOMY.

To the Editor of Engineering.

Sir,—Mr. W. L. Hichens could not have chosen a more important subject, both from the point of view of the welfare of the country and of employer and employee, than that upon which he deliberated at the National Economy Exhibition. What he said should ring in the ears of everybody connected with industry; especially should words sounded by such a champion strike home to the hearts of its captains.

It is now a well-recognised axiom that good results cannot be expected until perfect harmony exists between capital and labour; indeed, in the coming age of very keen competition the industrial firms at discord with labour will be gradually swallowed up by those who have sufficient foresight to predict the new order of things and adapt themselves accordingly.

I long ago came to the conclusion that the working man is not a monster; quite a lot can be done with him, providing he is fairly treated. If employers only studied a little more the interests of their employees, I am sure much good would result.

Would it not, then, be the proper thing for every big industrial organisation to form a special department, whose business would be none other than to inquire into the needs of their employees

A comprehensive report should be drafted for the careful consideration of the directors, who would decide whether it would pay them to adopt the measures recommended. The expenses of this department, created within the works, should not be heavy, and the results achieved more than compensate for them. The measures adopted for one works should not be stubbornly applied to another; but must be the outcome of the special conditions prevailing in each locality. One thing is certain. If you want your men to reduce waste you must first gain their devotion.

Yours faithfully,

A. S. Grunspan, B.Sc., &c.

20, Victoria-street, Westminster, S.W. 1,
May 25, 1917.

NOTES ON THE CONSTRUCTION OF TURBINE PUMPS.*

By ALAN E. L. CHORLTON, of Lincoln, Member.

(*Concluded from page* 512.)

IV. THE ROTOR.—As is well known, the internal design of a multi-stage turbine pump involves a rotor comprising a number of impellers keyed on to a shaft, the shoulders or bosses of which abut on each other and are secured and maintained together by double nuts or the like at, or near, the ends of the shaft. Such portions of the shaft as are not covered by the impellers, but are subject to the action of the pumped liquid, are protected by sleeves which fit up to the impeller bosses and thus make a complete sheath outside the shaft itself, Fig. 1 (*b*) and Fig. 2 (*a* and *b*), &c. (page 509 *ante*).

This rotor revolves within the guide chamber and housing, each impeller running at some points in the closest proximity to the partitions dividing the pressure stages and return guides.

These so-called running joints or neck rings must be so maintained by design and construction as to secure in continued service the smallest possible hydraulic leakage back from stage to stage, or mechanical loss by rubbing friction, both of which affect the efficiency and wear and tear of the pump. As a question of practical importance the design of this combination probably follows next to that of the successful automatic hydraulic balancing of the axial end-thrust. We have in it the question of the deflection of the pump shaft; the reinforcing effect of the surrounding impellers; the support afforded by the bushes, if any, between each stage, and the loss by bush friction (wear); the form of neck ring to reduce leakage; and the effect of keyways and keys, &c., all independent of each other and affecting the whole.

The ideal condition is that of a rotor supported in lubricated bearings with a shaft of such sufficient stiffness between supports that the deflection, under all possible running conditions, is less than the clearance allowed at the neck rings and intermediate bushes, so that no contact takes place between the rotating and fixed members, this clearance at the neck rings and intermediate bushes being kept down to the smallest possible limits. It will be seen that it is impossible to present mathematically the exact conditions with such a number of incalculable factors to take into account. For instance, it may be thought that a not inconsiderable reinforcing effect is obtained by the combination of the impellers outside the shaft as a whole. In practice, however, it is not advisable to lock up the impellers together shoulder to shoulder against each other by the end-nuts in order to get the advantage of the reinforcing effect, because, due to, amongst other things, the slight inaccuracies of manufacture in squaring the shoulders of the impellers, sleeves, &c., the result would be to throw the combination out of truth, that is, to distort the shaft. It might be contended that this need not be so, but even then provision must be made for dismantling in a mine or similar place, with its obvious attendant disadvantages, and the possibility of rough treatment taking place; furthermore, as a safeguard against heating up and consequent expansion of the outside combination (bronze) against the internal (steel) shaft due to accidental contact with the intermediate bushes, running, perhaps, when the pump is empty, suitable expansion should be allowed for, and the impellers, to ensure this, must not be locked tight against each other.

The supporting effect of the bushes on the shaft, in passing through the diaphragm intermediate between the impellers, is very difficult to allow for exactly; it may be that the bushes will decrease the deflection of the shaft by a material amount, but it must not be assumed for one moment that they are bearings of such a nature as lubricated bearings. Intermediate bushes can only, in some cases, be considered as water-lubricated supports which will act as such so long as a certain low surface pressure on them is not exceeded; if too great pressure comes on, heating takes place on account of the high speed of rotation. The effect of wear has also to be taken into account, for the hydraulic pressures at the two ends of these bushes are different, and there is, therefore, always a flow taking place through them, carrying with it any sedimentary or foreign cutting matter which may be in the water. This state of things causes the supports to wear more or less rapidly so as to become almost useless, the pump eventually arriving at a condition worse than if a suitable clearance had been allowed at the first.

The author believes that too much use is made of these intermediate supports in turbine pump design. It is found in practice that an internal bearing, to be successful, must have the same water pressure at both ends, and must be properly lubricated with good grease; it then gives excellent results. We are thus left with the fact that we are practically dependent on the shaft itself for the necessary strength and stiffness to allow of fine internal clearance, and the importance of a good design which will economically give the minimum deflection of spindle at once becomes apparent.

The factors affecting the deflection of a turbine pump spindle are:—

Static
- (*a*) The weight of spindle and distribution of diameter change;
- (*b*) The weight and distribution of impellers, balancer, and parts;
- (*c*) The number and span of supporting bearings; and

Dynamic
- (*d*) In the dynamic condition, other incalculable forces entering into account, such as centrifugal forces due to the out-of-balance masses, and finally certain hydraulic disturbances.

(*a*) Should be as light as possible consistent with the necessary stiffness; in common practice spindles are practically parallel the whole length.

(*b*) Impellers and balancer should be grouped together as closely as possible, only allowing sufficient space for the water passages between the stages; also, the entire weight should be brought as close to the supporting bearings as possible.

(*c*) The span of supporting bearings plays such an extremely important part in the durability of the pump, in the possibility and preservation of fine clearances, in the whirling of the shaft and in the determination of the most economical size of spindle, that special notice will be taken of it.

(*d*) A loaded shaft supported horizontally between two bearings will "sag," and when rotated must suffer bending at every revolution. Also, there are bound to be certain out-of-balance masses in the rotor due to keys, heterogeneous composition of material, and the unavoidable variation in thickness of castings, &c. In addition, a shaft has vibrational periods due to its length

SPAN OF BEARINGS – THREE ARRANGEMENTS

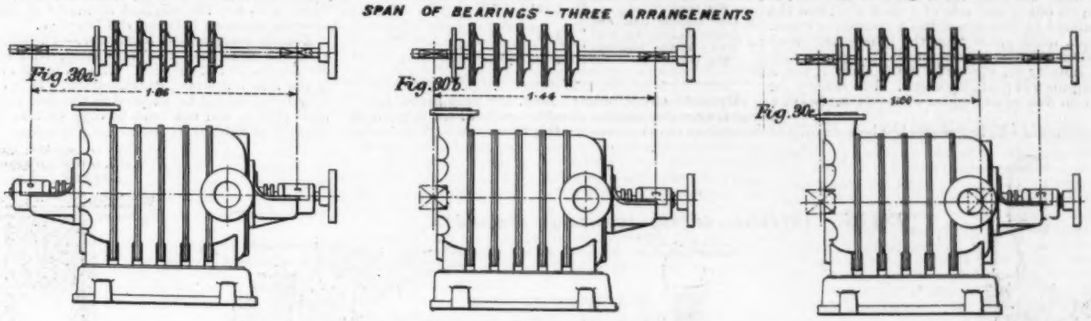


Fig.31. TYPES OF IMPELLERS

Fig.32. BED FOR "CYLINDRICAL" TYPE OF CASING.

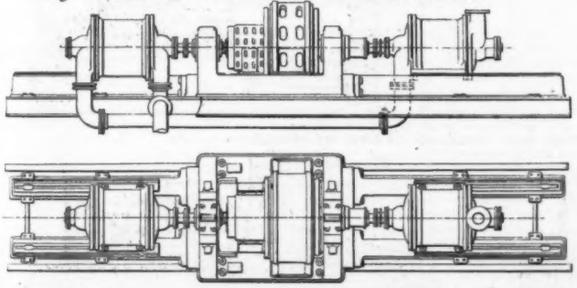


Fig.33. BEDPLATE FOR "RING" TYPE OF PUMP.

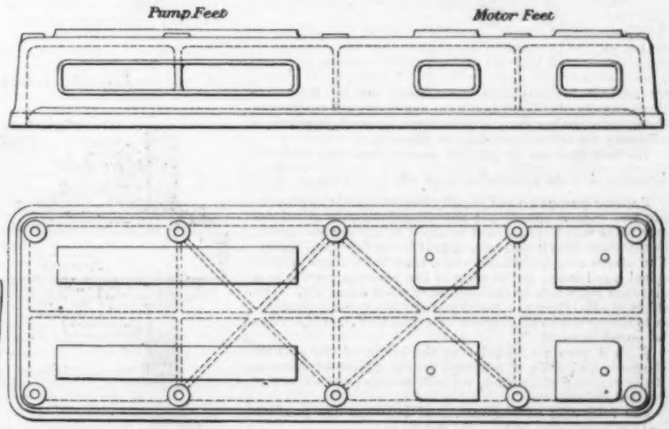
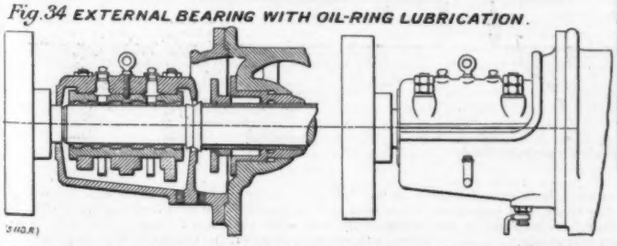


Fig.34 EXTERNAL BEARING WITH OIL-RING LUBRICATION.



* Paper read before the Institution of Mechanical Engineers, May 18, 1917.

and diameter, the whole question of vibration being intensely complicated by the loading and supports.

In addition to the disturbing factors mentioned above, vibrations are set up from the reaction of the impeller vane passing the guide vane. It is usual to reduce the intensity of this disturbance by arranging an odd number of vanes in the impeller relative to the guide vane, and by setting successive impellers on the shaft in such a way that the point of passing-vanes is progressive throughout the series, *i.e.*, a "lead" is given. The resultant of these arrangements is to produce a vibrating influence, which may be torsional or combined torsional and transverse, of very high frequency and enfeebled intensity and which, when properly carried out, is free from practical disadvantage. The damping effect of the water film in neck bushes is appreciable in overcoming slight vibrations, as is conclusively shown by the different behaviour of a spindle when running a pump dry and when running it filled with water. In order for a shaft to oscillate, it must force liquid out of one side of a neck ring, and the retardation offered by this action has a noticeable effect. For this reason, quite apart from the lubricating effect gained, it is always a wise precaution to fill a pump with water before running it, otherwise if the shaft is not a stiff one seizing-up will probably occur. The remedy for spindle vibration due to any cause whatever is always a stiff shaft.

The whole matter of whirling shafts has been examined by several investigators, prominent among whom is Professor Dunkerley,* but it is not proposed to discuss the matter further than to refer to the general proportions affecting the critical speeding of whirling.

We find that the length l of span of bearings, and the diameter d of the spindle have an effect varying as $\frac{d^4}{l}$ †.

Turbine pumps do not usually run at speeds approaching the critical speed, but the maximum safe speed for any rotor will bear a direct relation to the critical speed, in the sense that it will be an equal factor for equal safety. The above relation shows, then, that for a fixed critical speed a reduction in the span of the bearings results in a material reduction in the necessary shaft diameter. The effect of axial thrust—always present in a turbine pump—in lowering the critical speed of a spindle‡ should always be borne in mind.

With a view to considering the effect of the spindle diameter and span of bearings on the degree of fineness of the running clearances, we will consider the extent of the deflections.

The following arrangements of bearings are possible and are illustrated in Fig. 30 (opposite):—

1. Two outside bearings.
2. One outside and one inside bearing.
3. One outside and two inside bearings.

A typical example was taken, and it was found, after drawing out the different arrangements, that the ratios of the spans of the bearings supporting the loaded shaft were, for the three cases, 1.86, 1.44, and 1 respectively, calling the shortest span unity.

As the deflection of a circular spindle is proportional to $\frac{l_3}{d_4}$, the deflections themselves for the above spans are proportional to 6.5, 3, and 1 respectively, or, the necessary sizes of spindles to maintain the same deflections are proportional to 1.6, 1.3 and 1. These results are conveniently tabulated in the next column.

It will be noted that no allowance has been made for the buoyancy of the medium (water) in which the rotor revolves. The great importance of keeping the distance between bearings in a multi-stage turbine pump as short as possible is abundantly clear from the foregoing, for, with the more or less customary type, Case 1, Fig. 30 *a*, without outside bearings at each end, it is seen we have a deflection of six and a half times that of a pump with two internal bearings.

The direct result of this extra deflection is that the clearances between the outside of the eye of the impellers and the neck ring must be increased to allow of the impellers revolving without touching, and this increased clearance necessarily means a correspondingly increased leakage and loss of efficiency. Further, as has been shown, the passage of a large volume of water through the running clearance means increased wear and a tendency to push the walls apart, and therefore to force the impeller and shaft still farther out of the straight, with consequent friction against the adjacent neck-ring surface.

Case.	Ratio of Span	Ratio of Deflections.	Ratio of Spindle Diameter to Preserve Constant Deflection.
1. Two outside bearings (Fig. 30*a*)	1.86	6.5	1.6
2. One outside and one inside bearing (Fig. 30*b*)	1.44	3	1.3
3. Two inside bearings (Fig. 30*c*)	1	1	1

Dynamic out-of-balance may, and very probably will, exist, even though considerable care has been taken in the workshop to overcome it; this factor is a very important consideration, and calls for a very stiff shaft to resist its possible occurrence, because if the shaft and impellers are thrown out due to this, then further clearance at the neck rings is necessary or abrasion will result.

The question of the reactive effect of an impeller discharging unequally round its circumference is capable of so many variations that the only practical way to overcome this also is a mechanical construction that will resist deflection, that is, a stiff shaft. There is a further disturbing influence which is more active in smaller pumps, namely, the effect of the hand-packed and often ill-adjusted stuffing-box and gland; this detail is always standard for one end of the pump, and sometimes found at both suction and delivery ends. Apart from the cutting effect of such a packing on the shaft or its sleeve, it also, by reason of its compression in screwing up, tends to set the shaft out of the true centre, and so may intensify many other similar influences. The risk of outside bearings, separate or overhung, being slightly out of centre must also not be forgotten. For very many reasons, therefore, it is extremely important that the distance between bearings be kept as short as possible, and to do this successfully, internal, specially designed, large diameter grease-lubricated bearings are essential.

Summarising the effect of a long distance between bearings, we have:—

(*a*) Increased deflection of rotor.
(*b*) Increased neck ring clearance.
(*c*) Increased leakage from delivery to suction.
(*d*) Increased wear thereby, and
(*e*) Decreased efficiency.

Turning now to the dimensions of the rotor, the table shows that the diameter of the shaft does not increase as fast as the length of span increases. However, a very serious increase in size (1.6 times) is entailed by the increase in span consequent upon changing from two internal bearings to two external bearings. Obviously increasing the diameter of the shaft will give the decreased deflection desired, but then it introduces a larger diameter of impeller boss and entrance eye, thus bringing about a corresponding drop in efficiency as well as more leakage owing to the larger leakage area consequent upon the increase in diameter of the boss and the neck rings. It is clear, therefore, that securing the stiffness of a shaft by increasing its diameter is an inefficient method, for, besides the increased area for leakage through the neck rings, we have much worse conditions of entrance in a larger and more rapidly rotating eye and inlet edge of the impeller vanes.

The desirable condition, therefore, from all points of view, is to use the smallest diameter of shaft with the shortest distance between the bearings.

Leakage between Rotor and Stator.—The leakage through the neck rings may now be considered under different conditions and clearances. The material of these rings is the first important consideration. It is obvious that a material should be adopted in the first place of such a type that it will not tend to drag or tear if accidently touched or rubbed by the running impeller. Material of a hard "short" nature like cast iron will meet this condition, and in practice the smallest clearance can be successfully run with such neck rings; they are, however, subject to corrosion, particularly with acid waters as are frequently met with in mines.

The impeller, for the reason of susceptibility to corrosion, together with considerations of the necessary strength to resist the centrifugal effects of high speed, is usually made from phosphor-bronze. We therefore frequently get in practice phosphor-bronze impellers running in phosphor-bronze neck-rings, though it is obvious that dissimilar metals would be preferable. A phosphor-bronze impeller with a cast-iron neck ring is a better combination, and will run with smaller clearances, but to get over the corrodibility of the cast iron it should be specially treated, or should be similar to that indicated for renewal balancer rings. Soft metals will not run with fine clearances, for if any rubbing is set up, temporarily or otherwise, through dynamic out-of-balance, or want of alignment from any cause whatever, the metal immediately drags and the pump seizes up. The softer the metal the greater the clearance necessary. White-metal neck rings have been tried, but were for this reason a failure. Lignum vitæ is possible, but owing to its uncertain expansion a liberal clearance allowance must be made; it provides, however, a material to meet special conditions (mostly stay-bearings in vertical shafts). Lignum vitæ is also frequently used in water turbines, tail-shaft bearings for ship's propellers, &c.

The form of neck ring is, in practice, confined to four forms:—

Fig. 35. INTERNAL GREASE-LUBRICATED BEARINGS

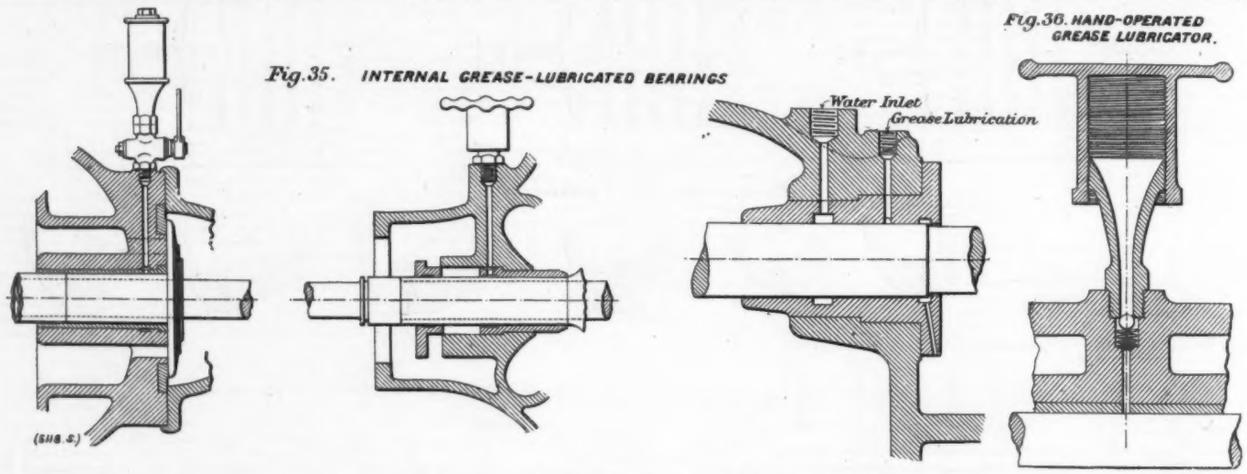
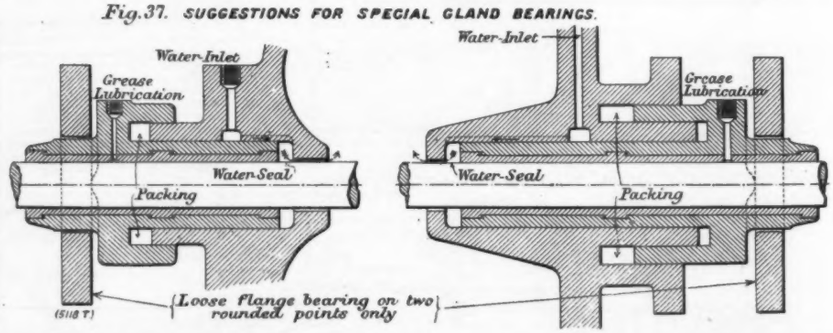


Fig. 36. HAND-OPERATED GREASE LUBRICATOR.

Fig. 37. SUGGESTIONS FOR SPECIAL GLAND BEARINGS.



* Trans. Royal Society, vol. clxxxv A, pages 279 to 360, also Liverpool Engineering Society, 1894–5.
† See Morley's "Strength of Materials," chapter xiv.
‡ *Ibid.*, article 166.

(*a*) Internal.
(*b*) External.
(*c*) Vertical.
(*d*) Labyrinth.
} Types of which are illustrated in Fig. 31.

The first is the usual form in turbine pumps, the second is more rare, the third is practically restricted to single impeller low-lift centrifugals, while the fourth is a refined form after steam-turbine practice, and is used in some high-lift pumps.

Between (*a*) and (*b*) there is little to choose, but for manufacturing reasons (*a*) is usually preferred. Clearances of a few thousandths of an inch per side can be run with a suitable shaft, and the leakage is very slight, less than 1 per cent.

(*c*) The vertical form is used in pumps for low lifts subject to dirty water and inferior attention. It allows of downward wear of the impeller without any rubbing surface coming in contact, which (*a*) and (*b*) would not. (*d*) is an attempt to reduce leakage further by a device of the kind used on the steam turbine.

For the reason that the labyrinth type deals with a non-expansible fluid like water, and not steam, it is far less effective than in the steam turbine, and in fact can only restrict leakage by the formation of eddies in the channels or grooves, shock losses at the sudden changes in area and direction, and the centrifugal effect of the rotating film of water in the narrow aperture. Its possible advantages in this way are more than negatived by its fragile nature if it comes in contact with the impeller, such a contingency usually involving the eventual renewal of both parts. Types (*a*) and (*b*) only require a new neck ring after wear. All types, however, are readily made with loose rubbing rings which may be easily changed.

In practice it has been found that when grooves were cut on the impeller shoulders to secure a labyrinth effect, and at the same time the neck rings were left plain, that after running for some time the marks of the grooves were always found on the neck rings, the difference between the worn surface and the original surface often being as much as ten thousandths of an inch, showing in these cases a deflection of the shaft greater than the calculated value. In these particular cases the fact that the grooves appeared all round the ring to the same depth indicated that they were due to actual deflection and not faulty alignment, the reasons for which may be found in the causes already enumerated and in mechanical inaccuracies. When interlocking grooves are used, the difficulties of erection and dismantling are increased unless the interlocking is in the plane at right angles to the axis of the pump; any other arrangement is of course only possible with horizontally split pumps or with split or divided neck rings.

V. THE BED, and other details. In the past, less importance has been placed on the effect of the bedplate than is now the case, with the result that frequently very shallow depths were used. These early beds were much too weak to resist warping strains due either to the unevenness of the foundation surface, the "pull" of holding-down bolts, or to the reaction of the torque from the motor end. It was a common practice to design bedplates in the form of two separate horns or branches, and in this case deeper sections were generally employed. This form of design, while undoubtedly stronger against bending, depends too much upon the skill of the plant erector and the solidity of the foundation always to give good results. It must be obvious that if fine internal clearances, such as have been dealt with, are an advantage, then the common base for the lot—the bedplate—must be of a nature to ensure the clearance remaining concentric and also to maintain true alignment with the operating motor. For these reasons deeper sections than are usual are an advantage. With the "ring" type of casing the bedplate plays a more important part than with the "cylindrical" type on account of the lesser intrinsic rigidity of the contiguous type and the greater necessity for a plane true surface in erecting; hence the importance of deeper sections becomes more pronounced still. It is now customary to have supporting feet on each "ring" of a multi-chamber pump, probably more for the convenience of re-erection in awkward situations than for any necessity for actual support. Chambers, when dismantling or re-erecting, require to be slipped along the spindle and bed, and for this reason it is usual to machine the latter for its full length. An example of substantial baseplate provision for a "cylindrical" casing is shown in Fig. 32, and a bed as recommended for a ring casing pump is shown diagrammatically in Fig. 33; in cases where there is a heavy torque from the driving motor, diagonal ribs as shown are most valuable in resisting twist on the bed.

Bearings.—The almost "standard" speed of 1,450 r.p.m. for the operation of turbine pumps does not require water-cooled bearings. For outside bearings good designs of oil-ring lubricated type as shown in Fig. 34 are used, a recommended feature being the provision of a thrower or guard to prevent water from a leaking gland entering the oil well and washing out the oil.

As has already been stated, to keep the distance between shaft supports as short as possible involves the use of internal grease-lubricated bearings, typical designs of which are shown in Fig. 35. This type of bearing, when carefully designed, can be made to operate very satisfactorily in practice despite a contrary view held for some time by some constructors. The important point of arranging for similar hydraulic pressures at each end of an internal grease-lubricated bearing, so as to prevent any risk of flow through the bearing surfaces, must be rigidly followed for best results.

The charging and supplying of grease to internal bearings requires proper lubricators. The ordinary "Stauffer" is unsuitable, though generally a hand-operated appliance of simple design (such as Fig. 36) meets the case; a long trumpet-shaped entrance is essential in order to force against the high pressure due to the head of water against which the pump is working. The selection of a good quality grease lubricant suitable for operating in water plays an important part in the satisfactory lubrication of a bearing.

Stuffing-Boxes.—It is doubtful if we can accept the customary stuffing-box and gland as good and satisfactory practice. The functions of this detail are, on the suction or vacuum end, to prevent air leakage into the pump, and on the delivery end to prevent pressure leakage from the pump. The action of "packing" on rapidly rotating shafts is so severe as to demand the omission of a stuffing-box wherever possible. On the delivery end of a pump it is easy to avoid a gland either by closing in the spindle, Figs. 3 (page 509 *ante*), 22 and 25 (page 512 *ante*), or by so reducing the pressure in passing through an hydraulic balancer that there is no pressure against which to pack, Figs. 4, 12 and 13.

Some constructors have done without stuffing-boxes at both ends of the pump for some time, and they generally rely on pressure water from the pump itself supplying the necessary packing to prevent access of air to the suction inlet. The possibility of difficulty in starting up a pump before the water packing is available should be carefully considered when this method is adopted.

Suggestions for the substitution of a special form of grease lubricated gland-bearing without any packing in contact with the rotating spindle are shown in Fig. 37. Though these bearings are not arranged with end pressure in equilibrium, there is no tendency for water to pass over the bearing surfaces, as leakage will take place from the water sealing ring to the reduced pressure of the suction inlet.

The author feels that the paper has run to somewhat greater length than he at first anticipated, but he hopes that some interest may be aroused, and perhaps some useful discussion on the details of the highly important modern turbine pump.

SHIPBUILDING IN HONG-KONG.—In one week, says *The London and China Telegraph*, Hong-Kong witnessed the launching of two of the largest ocean-going steamers ever built there. From the yard of the Hong-Kong and Whampoa Dock Company, Limited, was launched a ship of 3,500 tons deadweight, the Kwaisang, for the Indo-China Steam Navigation Company, and at the Taikoo Docks an ocean-going steamer of 6,000 tons gross and about 8,200 tons deadweight capacity, the Autolycus, built for Messrs. Alfred Holt and Co. Sister ships of these two vessels are under construction, and there is no reason why these ocean-going ships should not prove the forerunners of a great many others in the years to come. Mr. Greig, the chief engineer of the Taikoo Shipyard, speaking as president of the Hong-Kong Engineers and Shipbuilders' Institution, declared that Hong-Kong was capable of turning out any class of ship or marine engines necessary for commerce, and said the shipyards were, in fact, at the present time very busy in that connection, and he looked forward to seeing Hong-Kong occupying in the course of another ten years a position of even greater prominence among British Colonies for its shipbuilding industry than it did to-day. Hong-Kong shipyards have already won a reputation for first-class work, and as His Excellency the Governor remarked at the launching ceremony, in view of the plentiful supply of labour and the increasing number of skilled labourers in training under the guidance of the highly skilled technical European staffs employed in the Hong-Kong yards, the prosperous future of the great shipbuilding industry in the Colony is well assured. In this connection we may draw attention to the interesting announcement made by the chairman of the Hong-Kong and Whampoa Dock Company, that work has been started on an extension at the Kowloon Docks, which will give a shipyard of four berths 800 ft. long, and it is hoped in time to get it equipped for constructing "very large vessels." The principal dimensions of the Autolycus are:—Length over all, 441 ft. 6 in.; breadth over all, 52 ft. 4 in.; and 33 ft. depth to upper deck from bottom of keel. The total gross tonnage is 6,000, and the deadweight carrying capacity will be about 8,200 tons. The form of the hull has been designed to give the most economical vessel with the power installed, having straight water-lines forward and an easy run aft, the full midship section giving a very fine entrance. The vessel has two complete decks with an orlop deck forward, poop, bridge and forecastle, and citadel deck-house at fore end of bridge, two pole masts and ten derrick poles, also six cargo hatches. The machinery consists of one set of triple-expansion surface-condensing engines having cylinders 26 in., 44 in., and 75 in. diameter, with a stroke of 54 in., and is of the most modern design, having "Uniflux" type condenser, which assures a good vacuum being easily maintained with the minimum of weight. Edwards' patent air pump has also been fitted, and a separate centrifugal circulating pump of the latest type. When completed and on service the vessel will attain a speed of 13 knots. The Kwaisang, to carry 3,500 tons deadweight, is built of steel to Lloyd's Class 100 A 1. Her dimensions are:—Length over all, 301 ft.; length between perpendiculars, 290 ft.; breadth, 42 ft.; depth, 25 ft. The vessel will be fitted with one set of single-screw triple-expansion engines of about 1,500 i.h.p. and two main boilers 14 ft. 3 in. diameter by 10 ft. 6 in. long, with a working pressure of 180 lb., one donkey boiler 8 ft. 6 in. by 8 ft. 6 in., working pressure 100 lb. The auxiliary machinery comprises a steam-driven dynamo capable of lighting the whole ship, a separate centrifugal circulating pump, two Weir feed pumps and heater, large ballast pump, and two donkey feed pumps, and a Weir evaporator capable of producing 15 tons of water daily. Water ballast is carried in a cellular double bottom, and also one deep tank. She is designed to have a seagoing speed of 11 knots.

FOREIGN ENGINEERING PROJECTS.

WE give below a few data on a foreign engineering project, taken from *The Board of Trade Journal*. Further information can be obtained from the Department of Commercial Intelligence, Board of Trade, 73, Basinghall-street, London, E.C. 2.

Argentina.—H.M. Minister at Buenos Aires reports, under date March 23, that at the end of 1915 a scheme for the construction of 22 grain elevators at different places along the system of the Central Argentine Railway was placed before the Argentine Government by an Argentine firm, and that a presidential decree has now been issued approving the plans for the elevators. The materials and machinery for the construction and working of the elevators will be allowed to be imported free of Customs duties, the period for granting exemptions from payment of Customs duties on such materials and machinery having been extended from December 31, 1915, until December 31, 1917. The facilities previously accorded to the importation of iron used in grain elevator construction have been made applicable to other materials also. Elevators are to be constructed at the following stations of the Central Argentine Railway:—Acevedo, Arequito, Arrecifes, Armstrong, Canada de Gomez, Carreras, Chabas, Colon, Conesa, Correa, El Socorro, Firmat, Godoy, Marcos Jaurez, Paz, Peyrano, Rojas, Rojo, Rueda and Santa Teresa. Ten of the elevators are to be placed in service within a year from the date of the above-mentioned decree approving the plans, and the remainder are to be working within two years of the same date. The contract is to be signed within three months of the date of the decree. The firm referred to intended at first to form a company to build the elevators, but it now appears that it will be the sole owner, and will borrow the necessary capital. The name of the firm may be obtained by British firms interested on application to the Department of Commercial Intelligence. In making application the reference number (204) should be quoted.

PROJECTED TIN SMELTING WORKS IN LONG ISLAND.—According to *The Iron Age*, New York, an American company has been incorporated to carry on the business of tin smelting at Jamaica Bay, Long Island. Plans for a plant are being prepared, and in less than a year, it is stated, smelting will be begun. Only one unit, with an output of about 300 tons per month, will be erected at present. The company proposes to obtain tin ores from Bolivia. The smelting and electrolytic refining of Bolivian tin ores is already carried on in the United States, a works having been erected for the purpose at Perth Amboy (N.J.). Prior to the establishment of these works in the early months of 1916 practically no tin smelting had been done in the United States.

EXTENSION OF BUFFALO POWER STATION.—The engineers on the design and construction of the new power station of the Buffalo General Electric Company, says *Power*, New York, are at work on the details for the new 35,000-kw. extension, and it is expected that actual construction will be commenced very shortly The present turbine-room is large enough to contain the new 35,000-kw. Curtis turbine-generator, but the boiler-room will have to be extended to contain the new equipment of five 1,140-h.p. boilers. Until the new generator is installed these boilers will serve principally as relays for the present five boilers supplying steam for the initial installation of 60,000 kw. The new boilers are similar to those at present installed, being of the B. and W. type, fired from both ends by means of two Riley stokers having 15 retorts each.

ALLOYS INVESTIGATION IN THE UNITED STATES.—We read in *Machinery*, New York, that the Bureau of Standards, Washington, has undertaken to record the present state of knowledge and practice concerning the data on the properties of metals and alloys used by engineers and others, with the view of making generally available the most acceptable values of the constants. Forms are being sent out requesting the names of metals and alloys, conditions, chemical composition, &c. Some of the alloys for which data are particularly desired are aluminium and its light alloys with zinc, copper, &c.; nickel, monel metal, copper and nickel alloys, bearing metals &c. The collection of the data should result in securing information which will be of value to manufacturers, metallurgists and all concerned with the making and use of alloys.

HYDRAULIC POWER CONCESSIONS IN SWITZERLAND.—The official *Feuille Fédérale Suisse*, Berne, of December 27 last contains the text of a Federal Law, dated December 22, concerning the utilisation of water power in Switzerland. The Law lays down the principle of the general supervision by the Federal authorities of the utilisation of hydraulic power derived from public or private watercourses in Switzerland, leaving, as heretofore, to the cantonal and other local authorities the granting of concessions. The relative rights of the Federal, cantonal and local authorities and of the concessionaires are defined, and provision is made for protecting the interests of navigation, fishing, &c. It is provided that at least two-thirds of the directors of a concessionaire company must be Swiss citizens and domiciled in Switzerland, and that no transfer of the concession may be made without the consent of the conceding authority. The maximum period for a concession is fixed at 80 years. The *Feuille Fédérale* of April 25 contains the text of a circular sent by the Federal Council to the Cantonal Governments relative to the drawing up of local regulations to give effect to the above-mentioned Law, and fixing January 1, 1918, as the date of its coming into operation.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

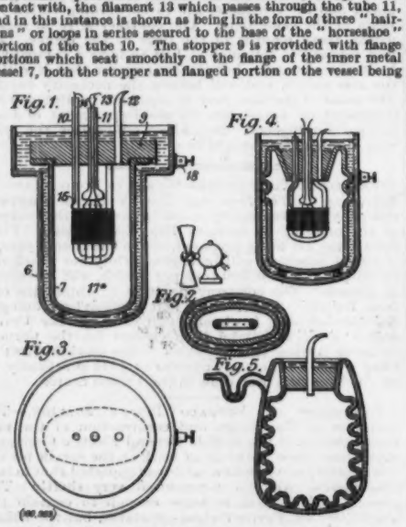
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

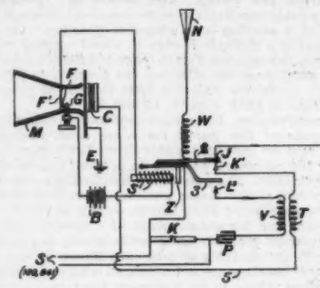
ELECTRICAL APPARATUS.

100,989. L. de Forest, New York, U.S.A. Electric Vacuum Devices. (5 *Figs.*) July 22, 1915.—This invention relates to electric vacuum devices with incandescent cathodes. 6 and 7 indicate respectively the outer and inner walls of the container, which are of metal. 9 designates the stopper or cover of insulating material, through which extend tubes 10, 11, 12. The tube 10 forms a "horseshoe" support for the grid electrode, which extends down therethrough to the point 15, where it passes out of the tube 10 and is wound around the "horseshoe" portion of the tube 10 and around, though not in contact with, the filament 13 which passes through the tube 11, and in this instance is shown as being in the form of three "hair-pins" or loops in series secured to the base of the "horseshoe" portion of the tube 10. The stopper 9 is provided with flange portions which seat smoothly on the flange of the inner metal vessel 7, both the stopper and flanged portion of the vessel being



preferably circular at this point. Mercury or other suitable heat-conducting air-sealing liquid is then poured into the vessel 6 sufficient in quantity to fill the space between the vessels 6 and 7, and to allow a level above the level of the stopper or cover 9. Thus it will be seen that there is provided an interior chamber 17a, completely air-sealed, which may be exhausted of air through any well-known evacuating means, such as an air pump (not shown), the exterior end of the tube 12 being sealed-off by the glass-blower's flame in the well-known manner, when the desired degree of vacuum is obtained in the chamber 17a. As metal is employed for the vessel 7, it serves as the wing or plate electrode, and the patentee has shown a terminal post, suitably secured to the container 6, to allow the necessary connection thereof, and consequently of the vessel 7 to the source of electro-motive force. (*Sealed.*)

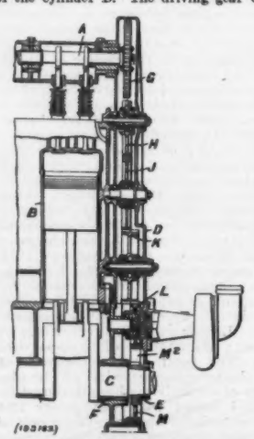
100,841. L. De Forest, New York, U.S.A. Wireless Telephone Systems. (2 *Figs.*) July 7, 1915.—This invention relates to automatic switching devices for use in connection with radio-telephone systems. It is among the special purposes of the invention to provide an automatic switch device which is voice-controlled to the extent of effecting an automatic connection of the circuits into a transmitting condition by the sound waves of the voice when a message to be transmitted is spoken into the transmitter, the apparatus being normally in receiving condition and being restored to receiving condition at the cessation of the voice sounds. N is the antenna of a radio system which, in the transmitting part, includes an oscillator K. Associated with the oscillator K is a capacity P and inductance V. J, K^1 are terminals designed to be put into circuit connection with the antenna N, through a conductor arm 2. The terminal J is in circuit with the receiving or detector circuit through wire X. The terminal K^1 is in circuit through the transformer coil T to the back contact of a microphone, the front contact of which carries a diaphragm. The diaphragm is connected to earth E. When the lever 2 is in contact with terminal K^1, the antenna earth circuit may be traced from the antenna N through the tuning inductance W, lever 2, terminal K^1, coil T, through the microphone to the earth E. This is the arrangement for transmitting. When the conductor lever 2 is in contact with terminal J, the antenna is connected to the receiving system. In practice, the lever 2 is normally in contact with terminal J, and in accordance with this invention automatic means operated by either the sound waves of the voice or by exhalation of the breath in speaking are provided to disconnect the lever 2 from terminal J and to connect it with terminal K^1. When the terminal is connected to the receiving system and the antenna earth circuit is opened at terminal K^1, it is also preferable to open the oscillating circuit. A terminal L^2 is therefore provided in the oscillating circuit with which co-operates a member 3 which is associated with the lever 2 to move coincidentally therewith. In the latter condition the oscillating circuit is closed and the antenna system is completed to earth. Associated with lever 2 and member 3 is a member Z constituting the armature of a slow relay S^1, a coil of which is included in circuit with a battery B, a contact G extending into the mouthpiece M of the microphone and with which co-operates a contact F on a loosely-mounted member F^1 suspended within the mouthpiece M and transversely there-across, in position to be held toward the contact G by the action of sound waves impinging thereon, or by the action of the breath exhaled by the operator when speaking into the mouthpiece. The operation is as follows: Assuming that the apparatus is in the condition shown, *i.e.*, in condition for receiving communications, the one receiving the communication, in order to reply without manually operating any switch, merely talks into the mouthpiece M of the microphone, the exhalation of the breath or the force of the sound waves impinging on the member F^1, causing the contact F thereof to make contact with the contact G, thereby closing the circuit of and energising the



relay S^1 and attracting the armature Z, breaking contact of lever 2 with the lead X to the receiving apparatus, and completing the circuit of the antenna through the microphone, through arm 2, contact K^1, diaphragm, and earth E, and at the same time by means of arm 3 and contact L^2 providing the necessary oscillating current through leads S, inductively associated with the antenna earth system through the coils V T. It will be seen that when speech ceases, contacts F and G separate, thus opening the circuit of relay S^1, and allowing the switch arms 2 and 3 to again resume the position shown and putting the system in condition to receive communications. (*Sealed.*)

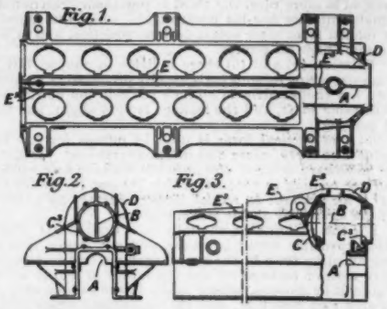
GAS-ENGINES, PRODUCERS, HOLDERS, &c.

103,163. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Camshaft Driving Mechanism. (1 *Fig.*) January 18, 1916.—In camshaft gearing for internal combustion engines there is employed, according to this invention, one or more broad spur gears, each of which is engaged at one side by its driving gear wheel and at the other side by its driven gear wheel. By the use of one of these broad wheels the gearing may be arranged in two planes, and by using a sufficient number of broad wheels in this manner the required staggering of the drive can be obtained. The camshaft A, which is arranged over the engine cylinders, one of which is shown at B, is driven from the crankshaft C through a train of spur gears located beneath a cover plate D. The first of these gears E is mounted upon the crankshaft, and, owing to the length of the crankshaft bearing F, the pinion E lies a relatively considerable distance away from the axis of the cylinder B. The driving gear G on the



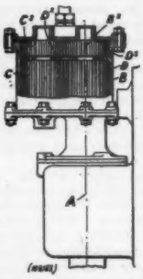
camshaft is comparatively close up to the axis of the cylinder, and it is desirable that this gear should not overhang more than is absolutely necessary. This results in the gears E and G lying on two different planes. The gear E drives the gear wheel G through an intermediate train of spur gears H, J, K, L and M. The gear M, in actual fact, is located between the gears E and L, but its axis does not lie in the same vertical plane as that of the axis of the other gears, and it is shown below the crankshaft for the sake of clearness, but it will be understood that it actually lies in the space indicated at M^2. In this train of gears one or more wheels is made of greater width than the adjacent gears. Thus the wheel K is practically twice as wide as the gear wheels J and L, and the wheel L drives the right-hand part and the gear wheel J is driven by the left-hand part of the broad gear wheel K. In this way the drive is transmitted from the crankshaft to the camshaft through spur gears which lie in different planes. (*Sealed.*)

103,159. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Crank Chambers. (3 *Figs.*) January 18, 1916.—In some high-speed aviation engines a reducing gear is arranged between the crankshaft and the propeller shaft, and this is generally located in a casing integral with, or attached to, the crank chamber. The invention is applicable to that type of engine in which the cylinders are arranged in two or more rows. According to this invention, there is formed on the crank chamber between each pair of cylinders a long web, the forward end of which is integral with, or attached to, the casing containing the reducing gear. The upper part of the crank chamber is provided with bearings for carrying the crankshaft, the axis of which is located at A. Above this, provision is made for a short shaft on which is mounted the propeller. The axis for this shaft is at B, and the bearings of the shaft may be located in the housings C—C^2. Between the crankshaft and the propeller shaft there is a reducing gear, which may comprise a pinion on the crankshaft driving a large wheel on the propeller spindle. Around the propeller spindle is formed a casing D, which encloses the greater part of the reducing gear, and it will be seen that it stands up above the greater part of the crank chamber. It will be clear also that this casing receives



through the bearings of the propeller spindle, all the pull of the propeller. To resist this pull, the casing D is connected with the whole length of the crank chamber by means of a long web E, of which the forward end E^2 is integral with the casing, whilst the rear end E^3 joins up with the rear end of the crank chamber. Thus the stress on the casing is distributed throughout the whole length of the crank chamber. (*Sealed.*)

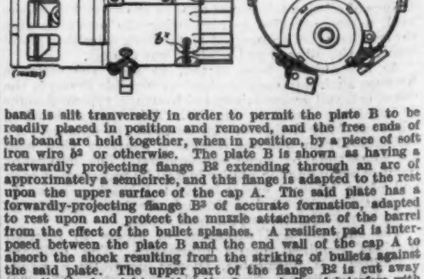
103,162. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Lubricating Systems. (3 *Figs.*) January 18, 1916.—In a lubricating system for an internal combustion engine, according to this invention, a double oil pump mounted upon a common driving spindle is employed, one part supplying oil under pressure to the important bearings, and the other part merely circulating oil to the less important points, such as the oil-retaining casings. A represents the axis of a vertical spindle, the upper end of which drives a gear wheel pump, the members of which are shown at B, C. Each gear



wheel pump member B or C is divided into a lower main part B or C, and an upper minor part B^2 or C^2, and the casing D containing the pump is formed with a partition D^2 which separates the pump members B, C from the minor parts B^2, C^2. The main pump B, C delivers oil to those parts of the engine which require most oil, if necessary under a high pressure. Such parts are the crankshaft and other important bearings. The minor pump portion B^2, C^2 delivers oil to the parts of smaller importance, such as the camshaft bearings and the train of gearing for driving the camshaft. (*Sealed.*)

GUNS AND EXPLOSIVES.

103,201. Sir A. T. Dawson and G. T. Buckham, Westminster. Machine Guns. (3 *Figs.*) February 25, 1916.—This invention relates to machine guns having a water-jacket around the barrel. According to the invention, the patentees provide an attachment comprising a protecting metal plate adapted to be connected to the water-jacket in a position contiguous to the end wall of the front cap or of the water-jacket, for preventing bullets or other missiles from penetrating the wall. A is the front cap of the water-jacket of the gun and B is the protecting plate. *b*, *b*, are rearwardly-extending metal strips, which are riveted at their forward ends to the plate B and at their rear ends are formed with loops b^1, b^1; B^1 is a retaining band passing through the loops, this band being situated around the portion of the water-jacket contiguous to the cap A, with its front edge in contact with the rear surface of the cap. The said



band is slit tranversely in order to permit the plate B to be readily placed in position and removed, and the free ends of the band are held together, when in position, by a piece of soft iron wire b^2 or otherwise. The plate B is shown as having a rearwardly projecting flange B^2 extending through an arc of approximately a semicircle, and this flange is adapted to the rest upon the upper surface of the cap A. The said plate has a forwardly-projecting flange B^3 of accurate formation, adapted to rest upon and protect the muzzle attachment of the barrel from the effect of the bullet splashes. A resilient pad is interposed between the plate B and the end wall of the cap A to absorb the shock resulting from the striking of bullets against the said plate. The upper part of the flange B^2 is cut away opposite the foresight so that the flange shall not interfere with the sighting of the gun. (*Sealed.*)